Analysis of enamel friction and wear during cooperation with ceramic materials used for fillings in dentistry

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As part of the research, the coefficient of static and kinetic friction was determined and the wear processes of ceramic materials used for fillings in dentistry during friction with enamel were identified. The research showed that there is an influence between the load and the change of the static and kinetic friction coefficient, and also significant wear of the enamel during the contact with the ceramic material. The entire study was supplemented with the analysis of changes on the friction surfaces using a scanning microscope, which showed the presence of clear signs of abrasive wear and microcracks on the enamel surface.

Keywords: dental fillings, dental ceramics, enamel, Cerec Block, IPS Empress

1. Introduction

In modern dentistry, chairside CAD/CAM restorations using 3D scanning methods are becoming more and more widespread. Many different materials are used to restore hard tissues defects. Medical corporations are developing entire systems that use branded ceramic materials. During operation, these restorative materials cooperate with natural hard tissues such as enamel. The effect of cooperation between artificial ceramics and natural enamel is being tested [2], but has not yet been sufficiently investigated. Ceramic material is much harder than enamel [1], and it can therefore have a big influence on premature wear. The influence of the use of ceramics on the proper functioning of the chewing process is still unknown.

2. Materials and methods

The two most popular CAD/CAM ceramic materials were selected for the tests: IPS Empress® (Ivoclar, Lichtenstein) and Cerec Block® (Vita Zahnfabric, Germany). These materials were tested against natural human enamel on tooth samples. Due to the variety of enamel properties, each test was performed with four different tooth samples. The tests were carried out in a reciprocating motion with 6 different loads in the range of 3 ÷ 15 N, which resulted in Herz contact pressures in the range of p_c = 165 ÷ 283 MPa. The tests were carried out with 10,000 cycles of 2x10 mm each, with the sliding speed v_s = 10 mm / s. The tests were performed in the presence of artificial saliva.

3. Results

On the basis of the performed tests, the mean values of the static and kinetic friction forces were determined and used to determine the friction coefficients (Fig. 1). Long-term tests allowed the wear mechanisms and the size of the wear trace of both the ceramic material and the enamel to be determined.

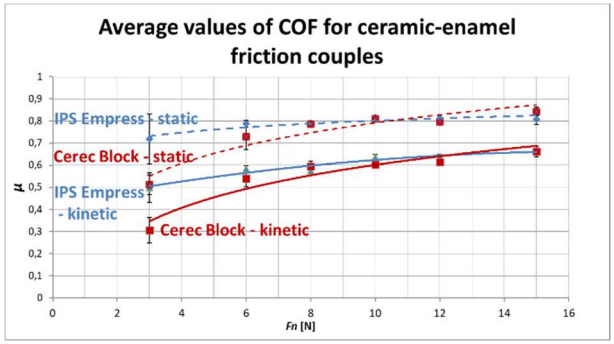

Figure 1: Static and kinetic COF with regards to the load for the tested friction couples.

4. Discussion

The research showed a difference in the values of the friction coefficients between the tested ceramics. The determined COF values for the tested friction pairs ranged from 0.31 to 0.84. The friction between Cerec Block and enamel is smaller than between IPS Empress and enamel. The value of the static friction coefficient is greater than the kinetic friction by about 24-25% in each of the tested material combinations. For both materials, an increase of contact pressure causes an increase in the coefficient of friction. This phenomenon can be explained by an increase of the real contact area between rubbing bodies.
Additionally, microscopic observations show the presence of abrasive wear and microcracks on the enamel surface.

5. References

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