The “Steger Method“, for dental abrasive measurements

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1. Introduction

The present study describes a method of measuring abrasion on the surfaces of three different materials found in dentistry: tooth enamel, dental ceramic (Zirkonzahn ICE Zirkon), and Zirkonzahn Prettau zirconia against an abrasive body (indenter).

As well known, dental abrasion is the loss of dental structure originated by an external mechanical force that acts over the tooth's surface [1-2].

Different causes for enamel abrasion had been studied, and has been reported that the typical abrasion in the premolars is about 15-20 μm per year [3].

Several research centers had developed special methods and devices to measure the mechanical properties of dentistry materials. Results of such studies are very important for understanding existing materials better and to gain understanding when developing new ones[4-6].

In earlier investigations had been studied the abrasion of enamel against some commercial ceramics by testing them using a modified Minimet polisher. Abrasion measurements had been reported, and had been found that one of the reasons producing this phenomenon is attributed to the surface finishing and porosity of the materials. [6]

The intention of this experiment is to quantify and compare the abrasion effect of these two materials used in the dental field, as well as to compare them with the abrasion effect over a natural tooth.

2. Methodology

Two abrasive systems, as seen in figures 1 and 2, had been built to reproduce the dental abrasive effect. Each abrasive system is built using a polishing machine which is set to work at 8,400 rpm (see figure 1.a). Two masses on each system are located on both sides of the machine to produce a final moment force of 48.5 N (5kg) over the samples surface (see figure 1.b). Such weight is selected in order to avoid load deformation, and to produce abrasion due to porosity and surface structure of the materials. A cube filled with water (figure 1.e) is arranged in such a way that the work between the indenter (figure 1.c) and the sample (figure 1.d) occurs under water level in order to cool the indenter.

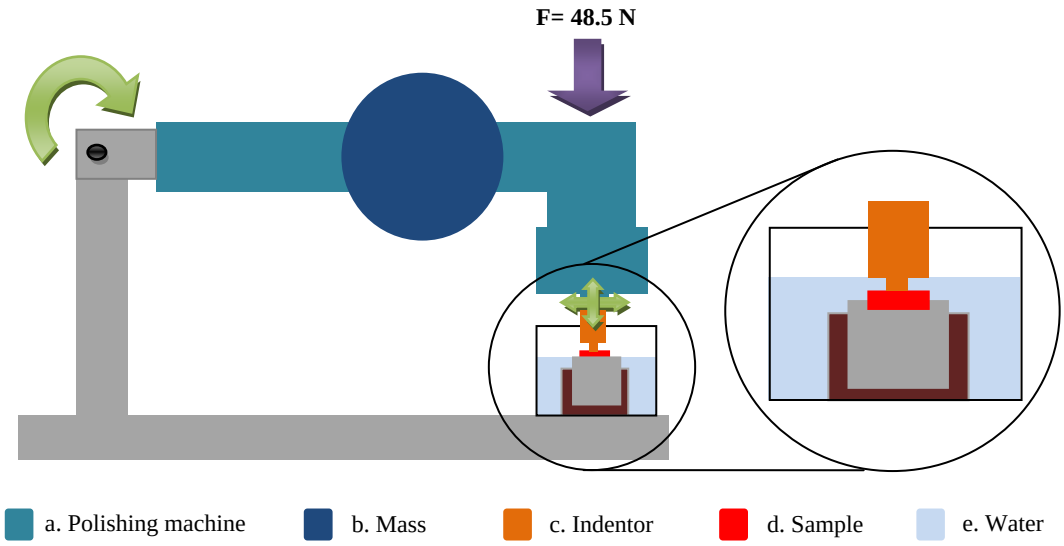


Figure 1, schematic view of the abrasive test system.

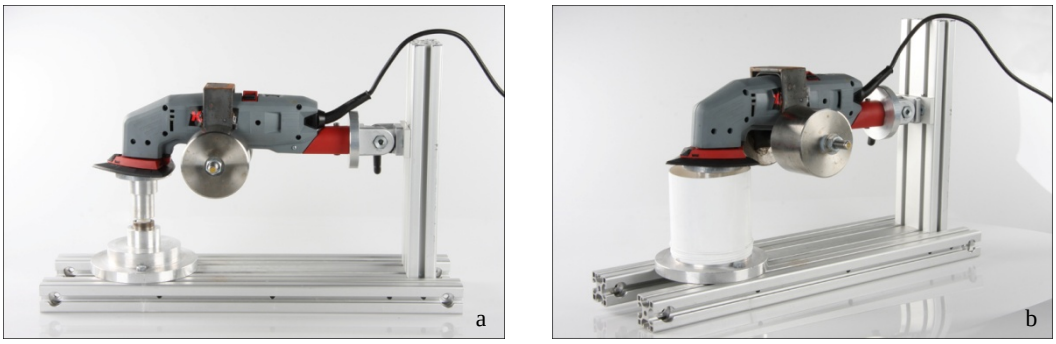


Figure 2 shows how the abrasion device. a) Without water cube b) With water cube

3. Sample Preparation

As seen in figure 3, an indenter (figure 3.a) and three different kinds of samples had been prepared. The first sample (figure 3.b) is a natural tooth, the second one Zirkonzahn ICE ceramic (figure 3.c), and the third one is a Zirkonzahn Prettau sample (figure 3.d). The surface of all three samples had been polished to get a flat full contact surface. The samples are not glazed since the experiment refers just to the abrasion properties of each material. In fact glazed surfaces could lead to imprecision of the measurements of the material properties.

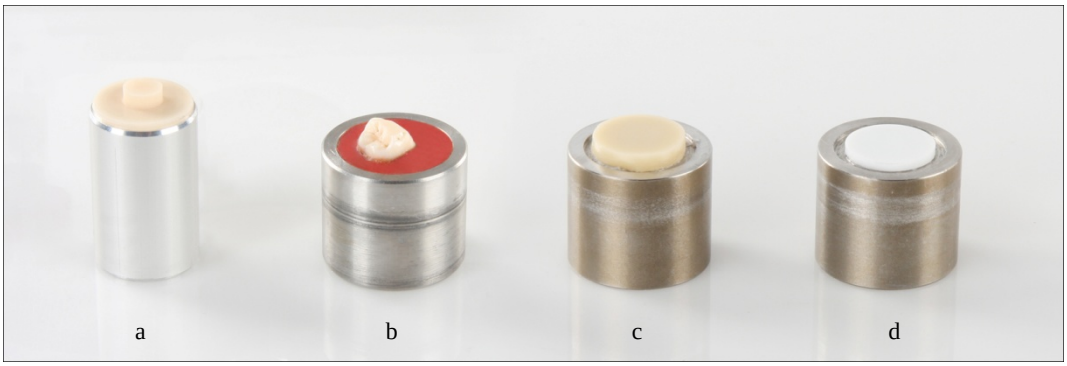


Figure 3 a) PMMA Indenter b) Natural Tooth c) ICE Zirkon Ceramic d) Prettau Zirconia

4. Indenter

As shown in figure 4, an indenter made of PMMA (Poly methyl methacrylate) with a diameter of 8mm had been prepared. The indenter is elaborated from PMMA because this material is water resistant and has high homogeneity. Such properties, allows the material to preserve its natural dimensions all along the tests and better precision in our measurements.

Figure 4, schematic view of the PMMA indenter.

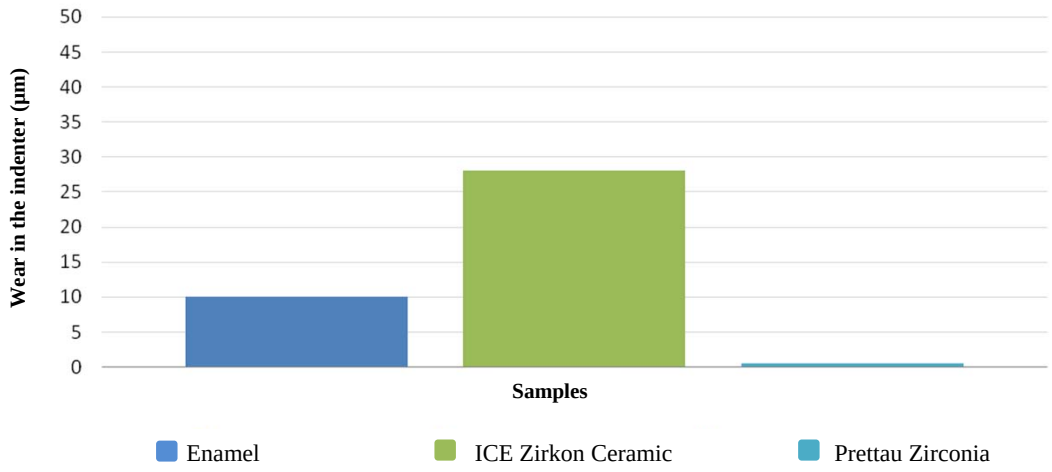
Figure 5 shows the contact set-up between the sample and the PMMA indenter without the water cube for better visualization.

Figure 5 shows the contact arrangement between material sample and the indenter.

5. Results

Several run offs had been carried out for 6 hours each one, which is equivalent to approximately 3.024 millions of cycles. The tests revealed the information contained in table 1.

Table 1. 8,400 RPM for 6 hours* with a weight of 5 kg over the sample:



* Equivalent to 3.024 million of cycles.

The measurements revealed that the Zirkonzahn Prettau sample generated zero wear to the PMMA indenter, while ICE zirconia ceramic developed an average wear of 28 µm and the natural tooth 10 µm of wear on the PMMA indenter. Figure 6 shows a schematic view of the abrasion effect on the PMMA indenter caused by each sample.

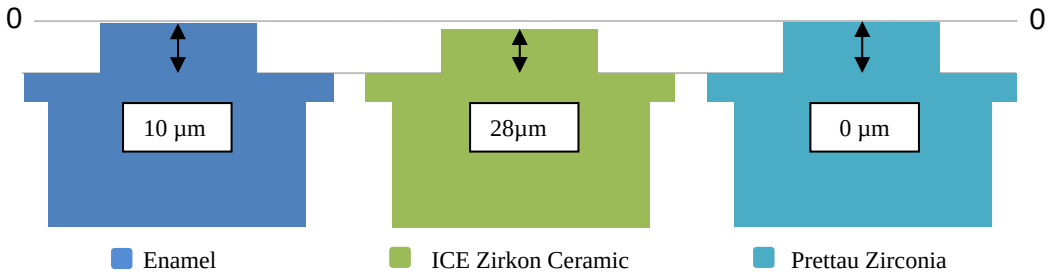


Figure 6, schematic view of the abrasion in the indenter according to each sample.

6. Conclusion

In the present study, the Zirkonzahn Prettau Zirconia shows to produce an average abrasion of zero due to its formidable non-porosity property, while a natural tooth develops an abrasion of 10 µm. Furthermore, the ICE ceramic demonstrated to be even 2.8 times more abrasive than the tooth enamel.

The results presented in this document are preliminary. Zirkonzahn will be involved in further studies in the future to provide additional scientific data about abrasive behavior of the materials tested.

7. References

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