Evaluations of dental resins wear considering its commercial cost.

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SUMMARY

Humanity has always been in search of better life conditions. In order to reach this objective, mankind has developed materials which are able to repair natural or accidental imperfections. Dental resins have been developed so that dental tissue loss could be repaired. Building a Biomaterial requires a considerably careful effort since it is an amorphous material that will interact with a living material. Besides all such care, it is necessary to pay attention to the manufacturing cost factor, because it will ultimately set commercial cost.

There is an array of dental resins available in the market. Variation of cost is a direct reflex of such variety. This article reports the tests of wear due to micro-abrasion, using *Test of micro Abrasion Ball Cratering*, in dental resins at cost range of 8 to 35 (4-g tube).

Inasmuch as people tend to mythologize dental resins, this article shall modify this belief. Low cost resins can be made available. This is uppermost to public health system in developing areas, especially to the low-income individuals in Third World countries.

Keyword – Dental resin, Ball cratering, abrasive wear and micro abrasion

1 – INTRODUCTION

Engineering main [3] purpose is to produce a machine or system that should accomplish a certain function within a certain specification..

Almost 30 years after this statement was made, the world has changed, several economic crisis occurred, economy turned globalized, and population impoverished. Provided all such phenomena, a new version of the statement can be coined. *"Engineering main objective is to manufacture a product that should accomplish its function, with high quality and low cost within a certain specification".*

Undeniable efforts can be observed in the social area; however it is inevitable that the economic power still rules the access to technology, health, comfort and welfare. In view of this, it will be a challenge for the engineers, scholars and researchers that are devoted to a Engineering that can be denominated of Social Engineering.

In this context, a number of different dental resins in the market is noticeable. They have a basic formulation yet different cost. Furthermore they are provided with little or no necessary technical information, and many times the price is the key factor for choosing the product, bearing the false concept that the more expensive the resin is the more durable it will be. This study intends to provide a technical tool that will contribute to choose the best dental resin, reducing the cost of dental restorations – key factor for public health.

Dental [4] resins stood out for several factors - both for aesthetic and technical reasons. As far as aesthetic is concerned, it is pointed out the recovery of the act of smiling – this fact turns humans into unique and special beings. Smiling is part of communication skills, and such gesture is a demonstration of positive attitude towards life. Concerning [5] technical factors, dental resins adapt to the teeth tone, they do not contain mercury in their formulation, they are easy to handle, easy to find in the market, easy to be replaced with a new filling. Furthermore they adapt to the food habits of population from different incomes and cultures. To sum up, they are a virtually perfect product.

Ideally, dental restoring materials should be worn similarly to the dental enamel however this process is rather unlikely to happen. There are several reasons that lead to the replacement necessity of these materials. In case of restorations, the reason is the abrasive wear that can be caused by brushing or the mastication. Hence, the study of such a phenomenon is necessary in order to estimate the composite resins performance. The study aimed at checking the effects of such competitive-cost resins in comparison to other types is described below.

2 – MATERIALS AND EXPERIMENTAL METHODS

The composite resins

The resins used in this study, their basic formulation and the size of the grains are described in table 01.

TYPE OF INORGANIC LOAD	AVERAGE SIZE OF THE PARTICLES.	% OF INORGANIC LOAD	COAST $	DENOMI-NATION
Ba Glass and Al Fluoride	0,7 µm	64 % in volume	22,72	A
Zirconium and Sílica	0,62 µm	82 % in weight 60 % in volume	31,81	B
Ba Glass and Al Fluoride	0,50 µm	80 % in weight	8,136	C
Ba Glass and Al Fluoride	0,55 µm	not supplied	17,72	D
Ba Glass and Al Fluoride	0,60 µm	79 % in weight 59 % in volume.	25,00	E
Ba Glass	0,7 µm	80 % in weight	7,27	F

Table 01: Used composites

The test of Micro Abrasion.

The *Test of micro Abrasion Ball Cratering* was used.

It is [6,7] an example of the test method that produces a well-known geometry (a cratered surface)[8], a sphere of hard steel whose radius R is rotated, as per illustration 1.

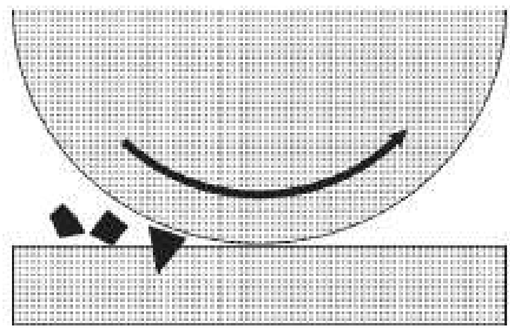

Illustration 1 depicts the mechanism of wear of an angular particle.

Abrasive particles are thinly and slowly dispersed over the test body.. The geometry of the sphere is reproduced in the test body, in order to get a well-known geometry, according to illustration 2. In this area, measurement of absorbed volume will be easily carried out.

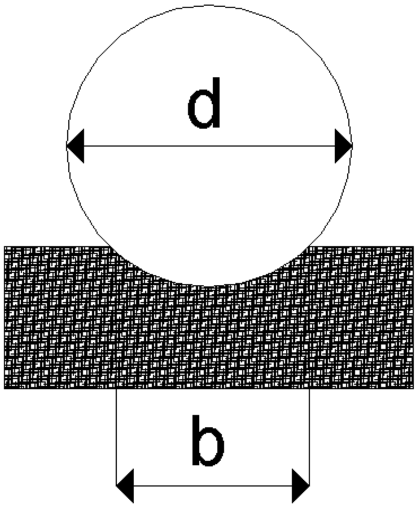

Illustration 2. It illustrates the crater left in the test body .

The illustration 3 display the picture obtained in optical microscope (I increase of 80 x)

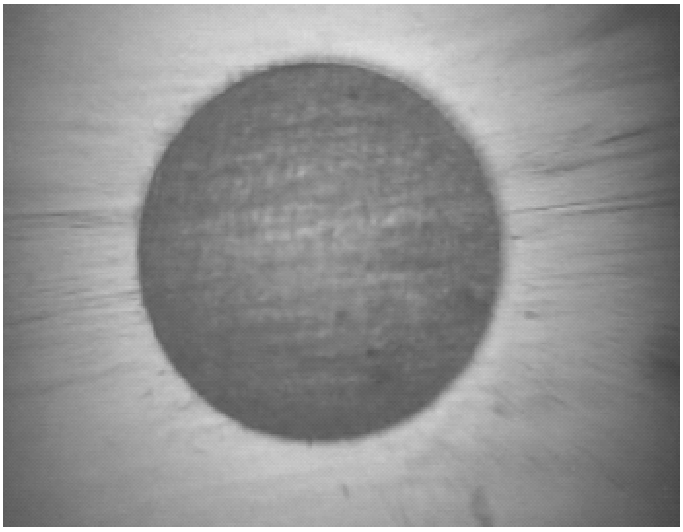

Illustration 3. Photo of the crater obtained in the
Test of micro Abrasion Ball Cratering, optical microscope, magnified by 80 x.

Considering well-known variables, the following equation can be used:

$$V = kSN, \qquad (1)$$

Where:

k - wear coefficient, in units of M^3/N.m
V is the removed material volume by usage,
S is the sliding distance in m
N is the normal load applied in N.
The wear volume can be calculated via:

$$V = \pi\ b4/(64\ R)\ ;b \leq R \qquad (2)$$

Where:

b - Diameter of the surface of the crater in m
R - Sphere radius in m

While making samples of direct use composite, it was used aluminum plates measuring 45 mm x 20 mm x 2mm thickness, with a central hole of 6mm diameter, where it was inserted the dental resins and a hole of 3mm, where the abrasive solution was added, as shown in illustration 4.

An aluminum plate was placed on a 2-mm glass laminate and the resin was added in a single increment using a spatula when preparing each of the resin test bodies for direct use. Subsequently, another 2mm-glass laminate was placed on the surface of the composite and compressed, leading to a flat surface.

The composite was polymerized from a 2mm-distance with *Led apparel*, LED RADII (manufacturer RADII) with potency of 680 $mW/cm^{2.}$

The abrasive solution in use was 20% w/w Aluminum Oxide, with 0,3-µm particles and distilled water. The abrasive solution was continually stirred during the test in order to keep the uniform solution. The spheres were made of steel ASTM 52100, with 15mm diameter. Those spheres were softened by 250 rpm before being used. In this case, a new sphere batch was used for each test set, the force in use was 0,5 N, 50-rpm rotation for test body, leading to a total of 10 test bodies per test set.

3 – RESULTS AND DISCUSSION

In this work, it is possible to conclude that cost does not affect the wear rate. However it may be affected by the food habits of each area. This can explain the success of some resins in isolated areas.

Even so, we should highlight that the wear coefficient figures obtained for the materials assessed in this work are pertinent to the methodology and parameters in use, providing a comparative index for their classification.

The diameters of the caps imprinted in *Test of micro Abrasion Ball Cratering* were carried out and measured in the Laboratory of Materials of the Federal Technological University of Paraná, Cornélio Procópio campus, using an optical Microscope coupled to an image analyser, accomplishing a total of 35 measures of the absorbed caps by *Test of micro Abrasion Ball Cratering*.

After getting such figures, the corresponding *wear coefficients k* were applied, through equation (1), as presented in table 2.

TEST BODIES	AVERAGE DIAMETER OF THE CRATERS (m)	WEAR COEFFICIENT (k)	COST $
A	0,0014	1,06711E-11	22,72
B	0,00143	1,16156E-11	31,81
C	0,00144	1,19439E-11	8,136
D	0,00136	9,50283E-12	17,72
E	0,00141	1,09793E-11	25,00
F	0,00143	1,16156E-11	7,27

Table 02: Wear Coefficient

If we classify wear Coefficient from the smallest to the biggest figure, it is possible to notice that commercial cost did not influence in the wear rate, as presented in table 03.

WEAR COEFFICIENT (k)	TEST BODIES	COST $
9,50283E-12	Resina D	17,72
1,06711E-11	Resina A	22,72
1,09793E-11	Resina E	25
1,16156E-11	Resina B	31,81
1,16156E-11	Resina F	7,27
1,19439E-11	Resina C	8,136

Table 03: Wear coefficient in increasing order.

In table 03, it is shown that materials in question had a similar performance in relation to the wear for *Test of micro Abrasion Ball Cratering* regardless of commercial cost; table 3 shows that the Coefficient of wear of the Resin D is much smaller than the remaining composites. This fact makes evident its considerable resistance to the wear in comparison to the other composites and we can point out that Resin F, which has a lower cost than the others, presented a wear coefficient performance within the same range of the other resins studied in this work.

3.1 - MORPHOLOGIC ANALYSIS OF THE WEAR SURFACE

It is unquestionable that the in vitro evaluation method cannot reproduce all biological conditions to which the resin will be subjected (oral environment, mastication force and food habits); it is a complex method let alone of difficult understanding, because not only does it depend on the experiment in itself, but also on the collaboration of patients. It is necessary to count upon their return for analysis of the restorations.
For these reasons, the in vitro method has been used in simulations of oral conditions that are submitted to the resins.

According to the photos obtained in SEM, it can be stated that both the crater borders of Resin B and Resin F bore the abrasion rather well. We considered that they are very resistant to the wear. Illustration 4 shows the measurement reading carried out in optical microscope and the illustration 5 shows its border definitions accomplished in *electronic microscope of sweeping* (SEM)

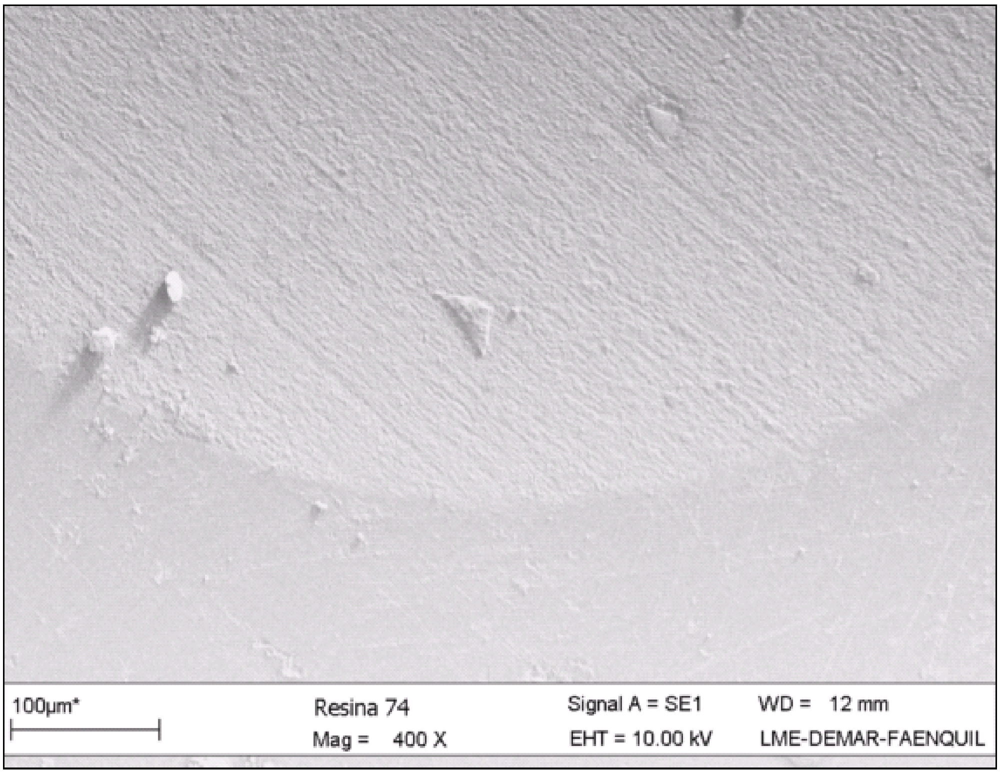

Illustration 4 . Photo of the border of the crater obtained in the *Test of micro Abrasion Ball Cratering*, SEM, resin B

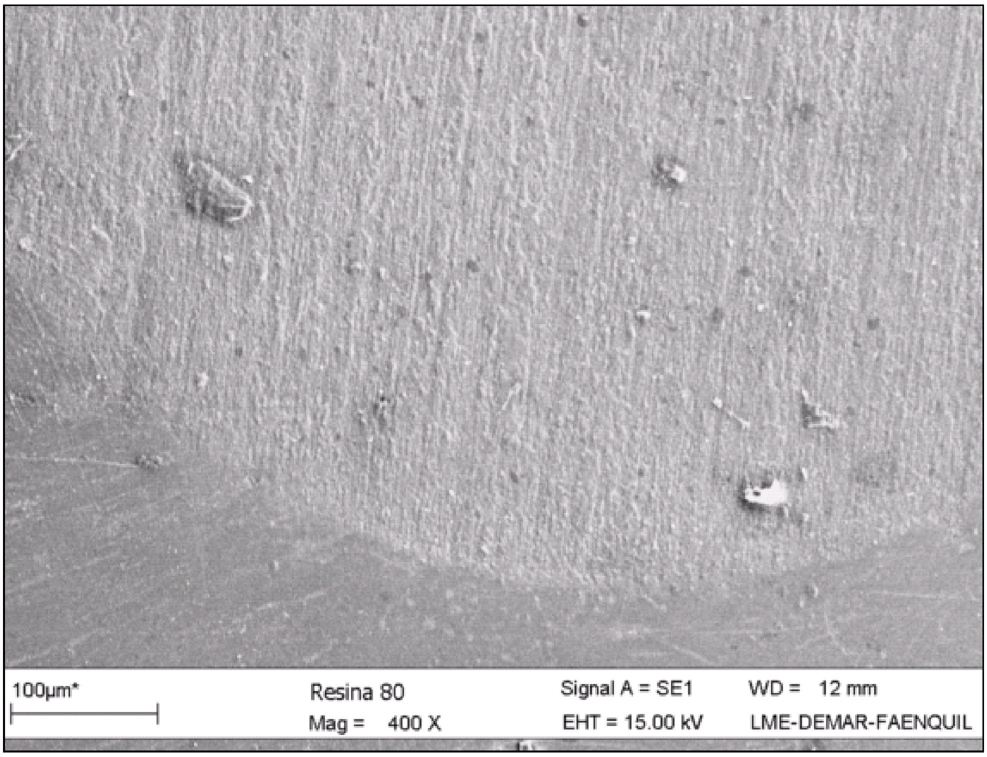

Illustration 5. Photo of the border of the crater obtained in the *Test of micro Abrasion Ball Cratering* test, SEM, resin F

Therefore, Resin F allows the smallest cost for dental repairs.

CONCLUSION

In this work, it is possible to conclude that cost does not affect the wear rate. However it may be affected by the food habits of each area. This can explain the success of some resins in isolated areas.

Even so, we should highlight that the wear coefficient figures obtained for the materials assessed in this work are pertinent to the methodology and parameters in use, providing a comparative index for their classification.

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