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ORIGINAL STUDY

STUDIES AND RESEARCHS ON BASIC CHARACTERISTICS OF SOME ELASTOMERIC IMPRESSION MATERIALS FOR DENTISTRY TESTED IN STANDARD CONDITIONS

Alexandru Mircea Nicolau[1], Vlad Gabriel Vasilescu[1], Elisabeta Vasilescu[2]

[1] " Carol Davila" University of Medicine and Pharmacy, Bucharest
[2] " Dunarea de Jos" University of Galati, Romania

elisabeta.vasilescu@yahoo.com

ABSTRACT

Among the materials used in dentistry, with particular importance in order to obtain accurate prosthetic restorations among are impression materials. Due to their execeptional qualities, both physical and chemical, synthetic elastomers and especially silicones and polyethers are now in first place among frequent materials used by dentists worldwide. Two of the many advantages of using elastomeric impression materials are those that they reproduce preparation details of the tooth surfaces and their dimensional stability over which was described in this paper. Also, through this research, we tried a comparison based on scientific experiments between four different silicone and polyether impression material, with relatively similar viscosities.

KEYWORDS*: fidelity, prosthetic field, dimensional stability, preparation dental stomatognathic system, silicone, polyester.*

1. Introduction

Dentistry, like all other branches of medicine, has undergone over time particularly intense changes because of the most important features of the living cell adaptability. The man, from appearance until now, has successfully managed to adapt to environmental conditions, which led structural essential changes both physical and psychosocial.

One of the structural levels at which adaptive natural changes occurred is stomatognathic system, which suffered changes in shape, structure, functions of jaw bones, number (in the sense shrinking), form and function dental units [1].

As a consequence of modern human needs, dentists have realized that in order to fulfill these desires of patients, but also for medical act responsibly, it is imperative to bring equipment, instruments and dental materials especially at the highest quality standards.

Thus, for studies, research and heavy investment, managed to obtain resources (equipment and dental materials) that can satisfy the conditions of the rigorous working techniques and indications for use, and the most demanding wishes of both the patient, as and the clinicians [2].

Silicone elastomeric impression materials and polyether are the most modern and most used impression materials used in dentistry. This is understandable, given that their physical and chemical properties are recommended for this area of medicine today. Among the physical properties, of particular importance in dental practice is emphasized by their fidelity and dimensional stability.

These two characteristics of elastomers refer to the ability of polyether and silicone impression materials to accurately reproduce details of the surface of dental Preparation and preserve these details for a period of time sufficient to allow optimum casting of accurate models. Also, they determine obtaining very accurate dental impressions and therefore of prosthetic excellence in terms of quality. Fidelity and dimensional stability of elastomeric impression materials can be influenced by various factors such as changes incurred during polymerization, which cause volumetric reductions, loss of alcoholic groups that favor contractions, water absorption and last but not least, temperature, disinfectants and fingerprinting methods and techniques [3].

All these factors must be considered when taking impressions, otherwise, they can adversely affect the quality of dental prosthetic rework.

The main aim of the study is to compare the in vitro fidelity and dimensional stability of elastomeric impression materials both silicone and polyether.

2. Material and Method

For this study we used four types of elastomeric impression materials, viscosity close, as follows:

ORANWASH VL (Zhermack). This is a condensation silicone hydrocompatibile with very low viscosity, suitable mainly for washing technique. The specifications of this material are presented in Table I mark.

Table I. *Technical data of silicone ORANWASH VL (Zhermack)*

Mixing time	30''
Total working time	1'30''
Time in oral cavity	3'30''
Time for Polymerization (setting time)	5'
Deformation pressure (minimum and maximum)	2%-8%
Elastic recovery	> 99%
Dimensional stability	< - 0,7%

ELITE H-D (Zhermack)

It is a VPS silicone low hydrophilic, for highly accurate impressions. The specifications of this material are presented in Table II mark.

Table II. *Technical data of silicone ELITE HD (Zhermack)*

Mixing time	30''
Total working time	2'
Time in oral cavity	3'30''
Time for Polymerization	5'30"
Deformation pressure (minimum and maximum)	3%-5%
Elastic recovery	>99,5%
Dimensional stability	< - 0,2%

AQUASIL L.V. (Dentsply DeTrey)

Silicone modified structure with very low viscosity, print materials found in the syringe. Can be used in combination with silicones with the same structure but different consistency in all dual techniques, but it is contraindicated in combination with polyether with a light cured silicone or polysulfide (table III).

Table III. *Technical data of silicone AQUASIL LV (Dentsply De Trey)*

Polymerization time	5'
Dimensional stability (ISO)	0,3%
Maximum pressure deformation	4.5%
Elastic recovery (ISO)	99.6%
Permanent deformation (ADA)	0.4%
Detail reproduction	<10μm

IMPREGNUM F (ESPE) It is a material based on polyether impression of medium consistency for manual mixing. The technique of this material data footprint are presented in table IV.

Table IV. *Technical data of polyether IMPREGNUM F (ESPE)*

Mixing time	45"
Polymerization time	6'
Retention time in the oral cavity	3'15"
Pressure deformation	3%
Pressure deformation	98,5%
Return after elastic deformation **Dimensional stability at 24 hours**	0,3%

According to SR EN 4823:2002, using a fidelity testing device (figures 1 and 2), made of a stainless steel block (steel or bronze), four impression materials were used to obtain four samples of different colors. (figure 3).

Figure 1. *The four components of the test piece*

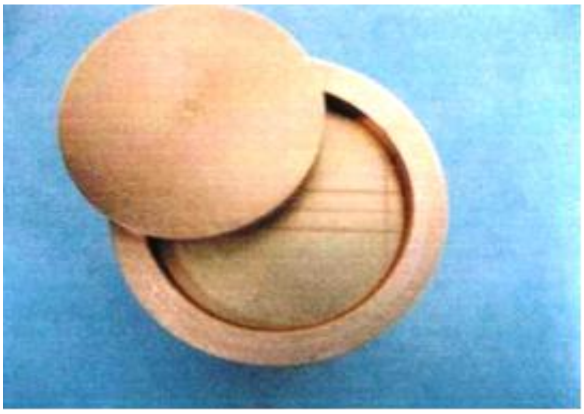

Figure 2. *The assembly of the test piece*

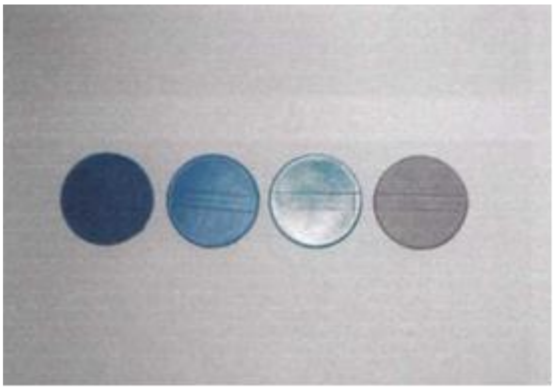

Figure 3. *The four samples of impression materials*

Subsequently, using the same working method described in section 4.c of the international standard and the current work, fidelity elastomeric impression materials were determined both qualitatively and quantitatively, using electronic microscopy ESEM XL30 and an electronic microscope with a maximum size magnification (X 300 000) (average size used in this study was X 100).

Qualitative analysis of elastomeric impression materials which refer to the reproduction test details (making measurements of the width of the test block ditches and design a statistical ANOVA study) of the same standard and quantitative analysis, measuring the linear dimensional variations (making measurements of distances between the ditches)were performed.

3. Results and Discussions

There were obtained, recorded and studied different results for both fidelity qualitative analysis of elastomeric impression materials, as well as the quantitative analysis.

For qualitative analysis we obtained the following results, contained in three tables: table V, table VI and table VII. Each of the three tables contain dimensions in μm of width of three parallel grooves on the test block and then the negative reproduction of these ditches, due to the impression material samples used in this study [29].

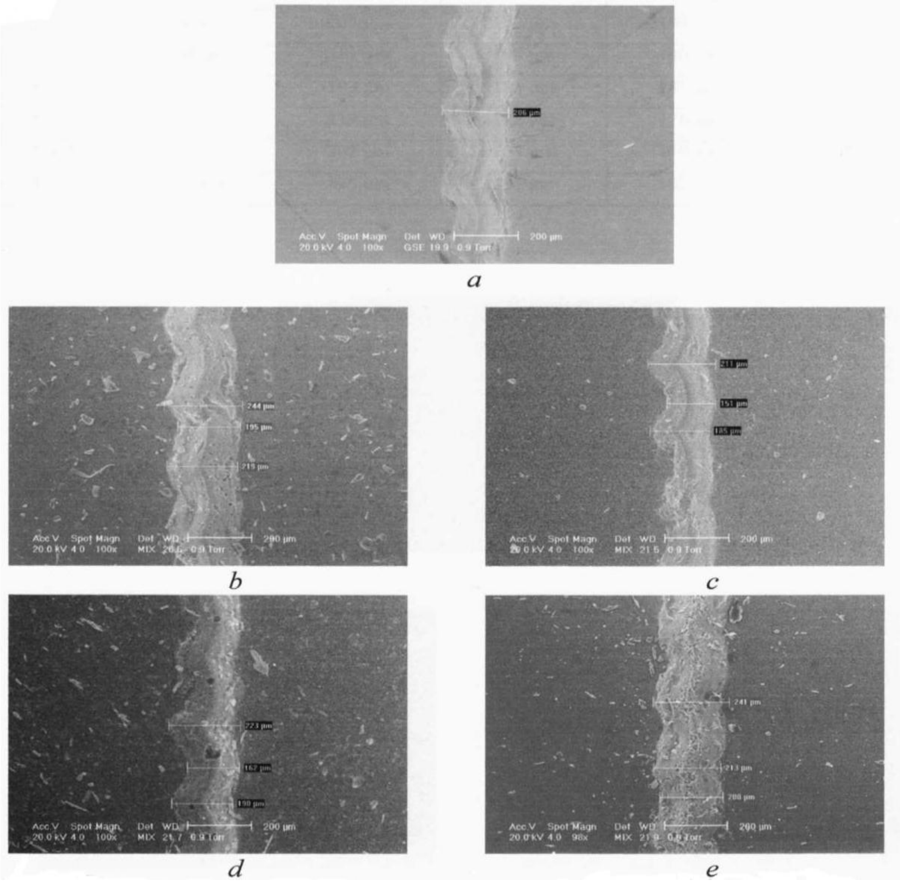

Figure 4. *Width of groove "a" (a- metal piece; b-on the sample ORANWASH VL; c - on the sample ELITE H-D; d – on the sample AQUASIL L.V.; e- on the sample IMPREGNUM F).*

Table 5. *Values of the trench width a in different areas, on five samples*

Width of groove „a"	Metal piece [µm]	Oranwash VL [µm]	Elite H-D [µm]	Aquasil LV [µm]	Impregnum F [µm]
Val.1	218	244	215	223	241
Val.2	210	232	211	219	232
Val.3	189	222	208	204	227
Val.4	206	205	187	194	212
Val.5	209	211	198	190	213
Val.6	196	199	185	185	221
Val.7	184	219	172	178	217
Val.8	175	202	164	169	209
Val.9	179	195	151	162	200

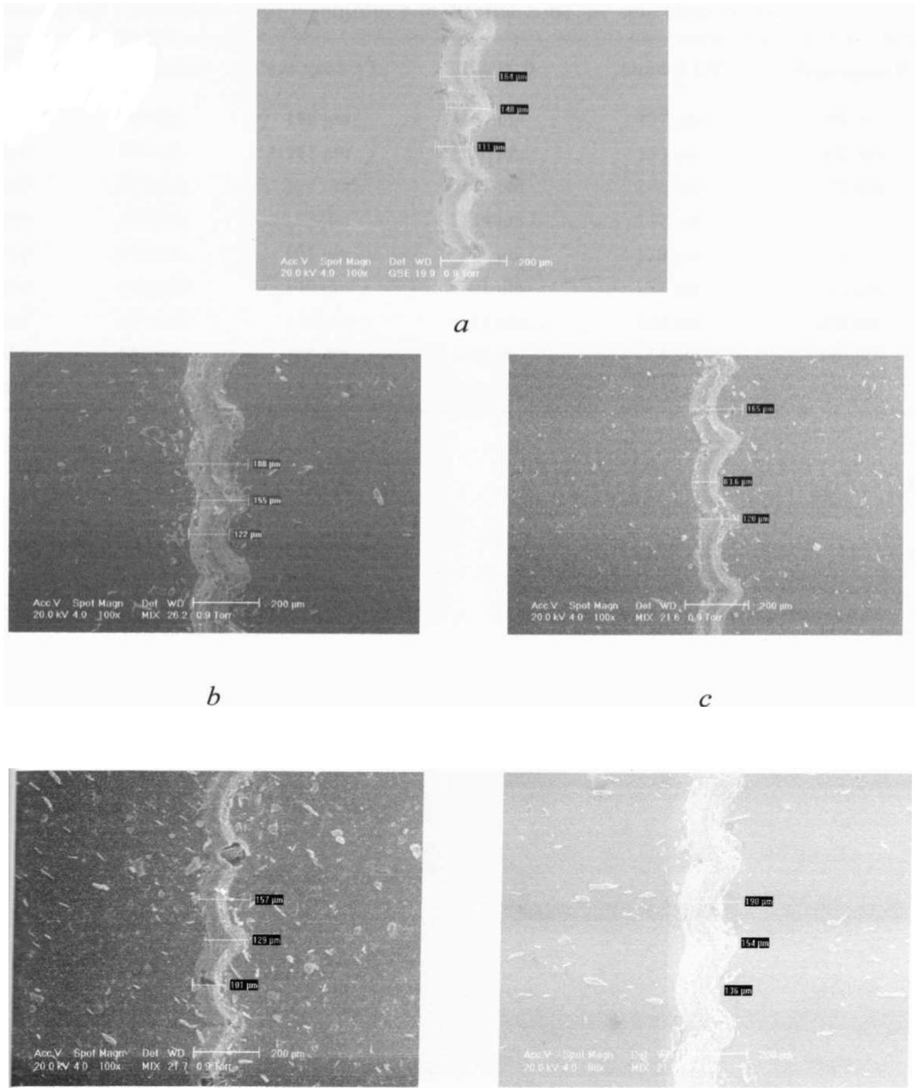

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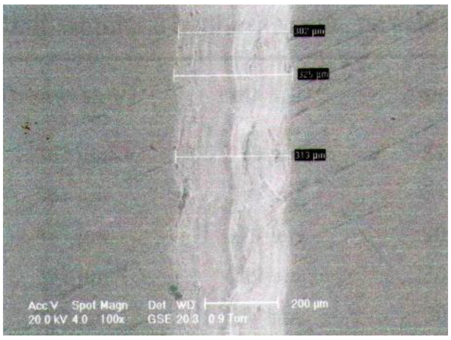
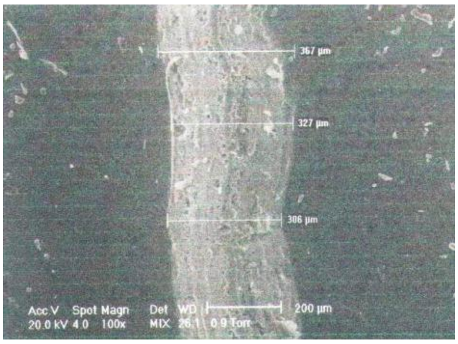
Figure 6. *Width of groove "b" (a- metal piece; b-on the sample ORANWASH VL; c - on the sample ELITE H-D; d – on the sample AQUASIL L.V.; e- on the sample IMPREGNUM F).*

Table VI. *Values of groove width b in different areas on five samples*

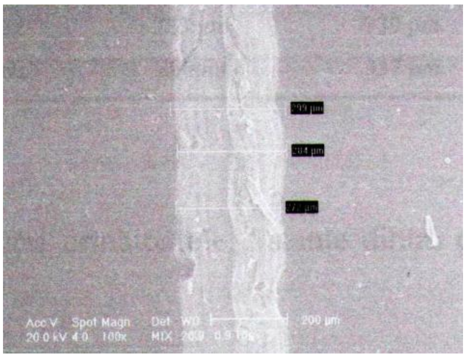
Width of groove „b”	**Metal piece [µm]**	**Oranwash VL [µm]**	**Elite H-D [µm]**	**Aquasil LV [µm]**	**Impregnum F [µm]**
Val.1	164	188	165	157	190
Val.2	158	181	156	153	182
Val.3	160	174	147	146	171
Val.4	153	163	134	137	158
Val.5	148	155	128	129	154
Val.6	142	140	101	132	162
Val.7	127	144	113	124	151
Val.8	131	128	98	114	144
Val.9	111	122	84	101	136



a



b



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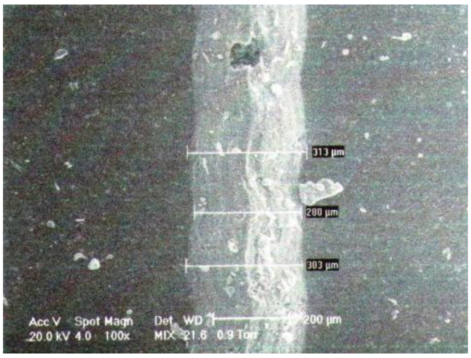

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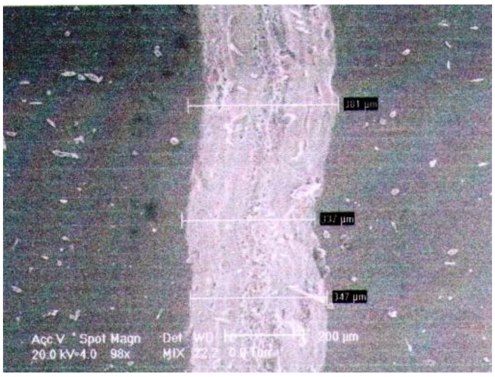

e

Figure 7. *Width of groove "c" (a- metal piece; b-on the sample ORANWASH VL; c - on the sample ELITE H-D; d – on the sample AQUASIL L.V.; e- on the sample IMPREGNUM F).*

Table VII. *Values of the groove width "c" in different areas on five samples*

Width of groove „c"	Piece of metal [µm]	Oranwash VL [µm]	Elite H-D [µm]	Aquasil LV [µm]	Impregnum F [µm]
Val.1	302	367	299	313	381
Val.2	371	361	296	311	378
Val.3	365	347	287	305	364
Val.4	334	351	289	309	353
Val.5	325	327	284	303	347
Val.6	327	323	277	299	340
Val.7	321	317	273	288	346
Val.8	318	311	280	283	339
Val.9	313	306	272	280	337

For quantitative analysis, we measured the following distances of the three parallel grooves on the test block:

- distance between the outer edges of the ditches "a-c";
- distance between the inner edge of the ditches "a" - "c";
- distance between the inner edge of the ditch "a" and the "b" ditch;
- distance between the inner edge of the "c" ditch and the "b" ditch. There were obtained the following results:

On the test block (figure 8):

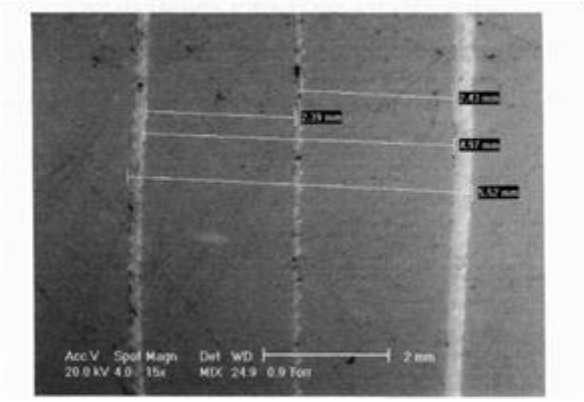

Figure 8. *Distances between grooves a, b and c on metal piece*

- Distance between the outer edges of ditches "a" and "c"=5.52mm;
- Distance between the inner edge of the ditch "a" and "c"=4.97mm;
- Distance between the inner edge of the trench "a" and the trench b = 2.39mm;
- Distance between the inner edge of the ditch "c" and the trench b = 2.43mm

On VL Oranwash the sample (figure 9):

- Distance between the outer edges of ditches „a" and „c" = 5.52 mm;
- Distance between the inner edge of the ditch „a" and c = 4.89 mm;
- Distance between the inner edge of the trench „a" and the trench" b" = 2.40 mm;
- Distance between the inner edge of the ditch „c" and „b" = 2.36 mm

On the sample ELITE H-D (figure 10):

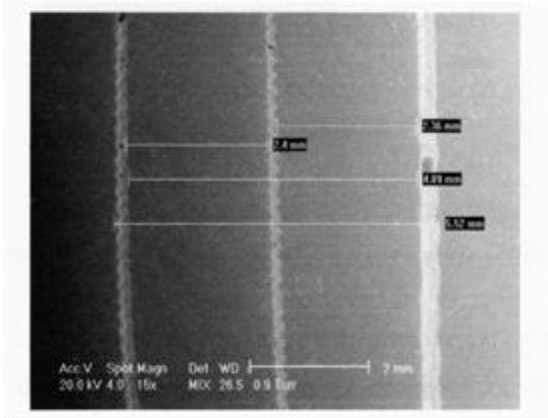

Figure 9. *Distances between grooves a, b and c the VL sample ORANWASH*

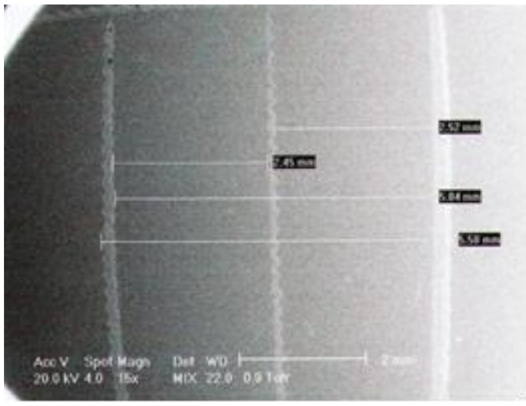

Figure 10. *Distances between grooves „a", „b" and „c" on Elite HD sample*

- Distance between the outer edges of ditches „A" and „c" = 5.58 mm;
- Distance between the inner edge of the ditch „a" and „ c" = 5.04 mm;
- Distance between the inner edge of the trench „a" and the trench b = 2.45 mm;
- Distance between the inner edge of the ditch „c" and „b" = 2.52 mm.

The sample Aquasil L.V (figure 11):

- Distance between the outer edges of ditches „a" and „c" = 5.55 mm;
- Distance between the inner edge of the „a" ditch and „ c" = 5.04 mm;
- Distance between the inner edge of the „a" trench and the „b" trench = 2.37 mm;

- Distance between the inner edge of the ditch „c" and „b" = 2.41 mm groove

The sample Impregnum F;

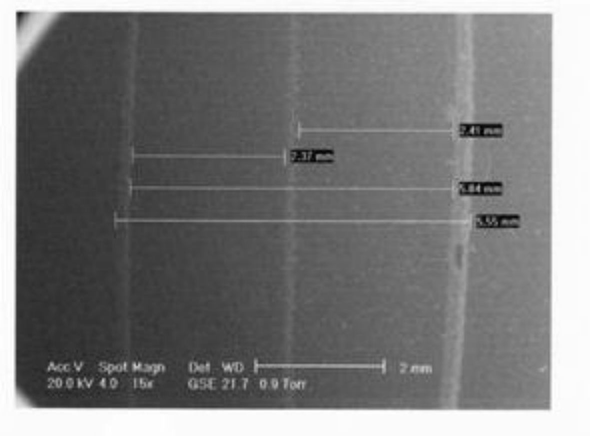

Figure 11. *Distances between grooves a, b and c on LV AQUASIL sample*

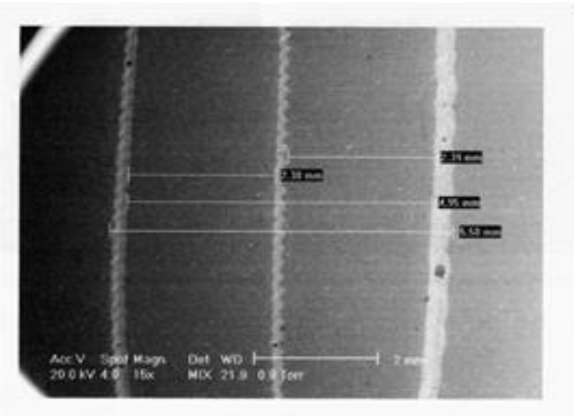

Figure 12. Distances between grooves a, b and c the sample IMPREGNUM F

- Distance between the outer edges of ditches „a" and "c" = 5.58 mm;

- Distance between the inner edge of the ditch „a" and „c" = 4.95 mm;

- Distance between the inner edge of the trench „a" and the trench b = 2.38 mm;

- Distance between the inner edge of the ditch „c" and „b" = 2.39 mm groove

4. Discussion

For qualitative analysis of the fidelity of last generation silicone elastomeric and polyetheric impression materials and polyester there were performed measurements through electronic microscopy, ESEM technique. It was analysed the width of three parallel ditches on the test block, ditch a, b and c, as well as the negative reproduction of the ditches in the impression, from the samples used in this research [4-6].

After completion of the measurements, we took into account that metal piece we used, although mostly corresponded to the original execution plan presented in the international standard SR EN 4823:2002, due to technical difficulties encountered in obtaining it, did not fully meet the characteristics plan. This was set at electronic microscope analysis where it was observed that the three parallel ditches on the test block (a, b and c) although it had to have a certain width each, they were uneven, so there were areas with different widths in the same ditch. It was decided that in order to overcome this drawback it would be recomended to make multiple measurements of the ditch and than use the results in a statistical ANOVA study. Thus, for each ditch were performed 9 measurements and the data obtained were noted in the three tables above [7].

In this statistical study reliable index was $\alpha = 0.05$. ANOVA study was used for superior validation of the results, and to make a comparison of the fidelity of the four impression materials described above and used in this research. For the second use, it is considered the index p The basic rule of an ANOVA study is that in order to have two or more groups (for example) equal, they must have the index $p > 0.5$ (when p tends to 1, the groups are equal). In the same way that two or more lots to be different, you must have $p < 0.5$ (if p tends to 0, then lots are very different).

For the second type of comparison, the same ANOVA study can be done by drawing some graphics based on the values recorded from the nine measurements for each sample ditch belonging to each impression material. Each graphic is created in the same coordinate axes: x (horizontal axis which is the axis of the test blocks and four samples of elastomeric impression materials used in the study) and y (which is the vertical axis and axis values are expressed in μm of the measurements made to determine the width of the three trenches in part). On X-axis of each graph, the coordinates 1, 2, 3, 4 and 5 are this: 1 represents the values recorded for a ditch from the samples of the impression material in the order presented in tables (Oranwash VL, Elite HD, Aquasil LV and Impregnum F). Thus, for ditch a was obtained following chart. (see figure 13) [7-8].

Compared to the median values determined for metal parts (test block) the nearest median values were obtained for Aquasil LV in a range of similar values, indicating that this material is the most accurate for this determination.

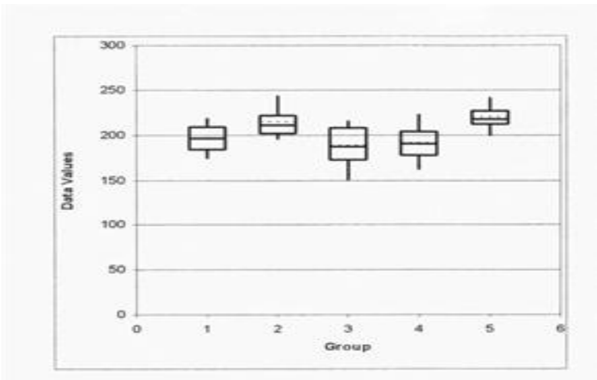

Figure 13. *Graph values trench width "a"*

Elite HD with a median although very little further, has a fairly large range of values, which means that the values on testblock can be easily obtained by taking an impression with this material. Oranwash VL and Impregum F, with median values furher from the median values of the metallic sample have a narrow range of values, which means that the values of the test block can be obtained only after a very hard and extremely accurate impression without any preparation vice or working technique. For ditch „b" was obtained following graph [9] (see figure 14):

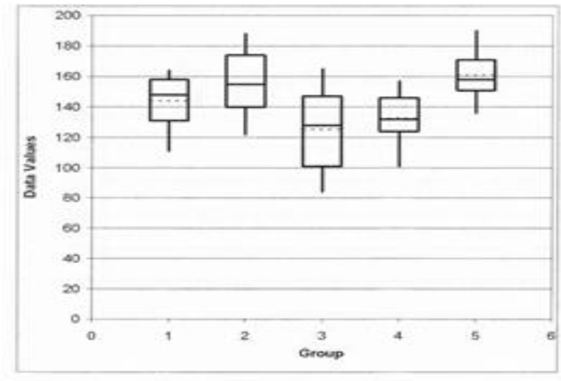

Figure 14. *Graph values for trench width „b"*

Same as the chart analysis for the ditch a, median values for ditch b from the metallic part as well as the range of values in which it fits are taken as a standard.

Thus, of all impression materials that were used to obtain evidence, the nearest median of values for ditch b was determined for the sample of Oranwash VL, with a mean close to standard values, indicating this as the most accurate impression material used for the determination.

In a decreasing order of fidelity, Aquasil LV is the next, which is getting closer considering the median values and the range of values of the block test chart. There follows Elite H-D which, despite the fact that it has the median values beyond the standard, has a very large range of values, which allows to obtain accurate impression easier than fourth impression material taken into consideration, Impregnum F, which although it has the median of values closest to the metal part even than Aquasil LV, has a smaller range of values and outside the standard limits.

For ditch c there was obtained the following chart (figure 15).

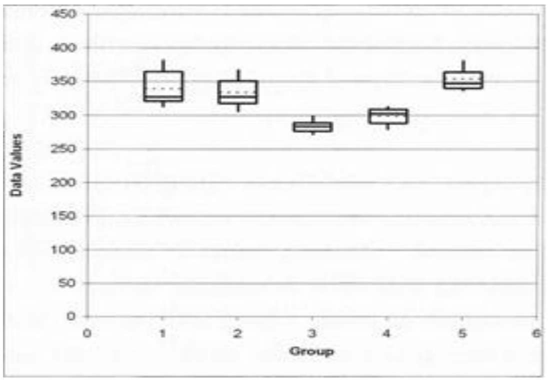

Figure 15. *Graph values trench width"c"*

Following the example of previous graphs there were taken for comparison all median values of the width of ditch c from the test block, and the range of values that these determinations are included. It is clearly seen that there are two types of materials: on one hand Oranwash VL, which, with a median and a range of values very close to standard emerges, regarding fidelity , and on the other hand VPS silicone Elite HD , with a median of values far from that of the metal piece and a narrow range of values without bisecting in any value in the standard. After Oranwash VL, in terms of fidelity lies polyether impression material Impregnum F, with a median of values pretty close to standard, but with a smaller range of values. Finally, another material with an intermediate fidelity for this determination, Aquasil LV, with a narrow range of values without common values with those of the test block, but with a median value closer to standard than Elite HD.

For the dimensional linear variation test, which consists in quantitative analysis of the study, the obtained results, presented in the results section of this chapter, confirm the same order of fidelity of the four elastomeric impression materials used, expected to qualitative analysis.

5. Conclusions

In order to assess fidelity of silicone elastomeric and polyether impression materials, there were comparatively tested four last generation impression materials according to EN 4823:2002.

These were: Oranwash VL (Zhermack) – condensation silicone, Elite HD (Zhermack) – PVS Silicone, Aquasil LV (Dentsply De Trey) – condensation silicone and Impregnum F (ESPE) - polyether. Out of the classes of impression materials tested, without making any commercial speculation, the best in reproducing the surface details, as revealed both in the electron microscope measurement results using ESEM technique, and the tables of values designed by ANOVA statistical study , were made by silicone ORANWASH VL.

Generally analyzing , all impression materials tested gave results more than acceptable, but, however, there were differences between the original surface details present on metal parts and their negative replicas on samples of impression material.

In conclusion, we can say that, using in the current dental practice any impression materials investigated in this study, there can be obtained exact prosthetic restorations of a higher quality level, only if there are rigorously followed the indications of the manufacturers, as well as exactly knowing the techniques and methods of impression taking, corresponding to each clinical case.

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