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The Hydro-Alginates Vs. The Addition Reaction Silicones: Comparative Study Between Mechanical and Chemical Properties of Two High-Fidelity Impression Materials

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ABSTRACT

Background: Choosing the proper impression material and the right method for a specific clinical situation, which can reproduce in an accurate way the details and dimensions of the prosthetic field, has the most important role in accomplishing fixed dentures. **Material and methods:** For this study we simulated a clinical situation in the laboratory using acrylic models, which helped us evaluate the differences between hydro-alginate impression and addition-cured silicones. **Results:** We found differences when comparing different parameters: time (2 minutes for hydro-alginates, 8 minutes for A-silicones), loss of material, dimensional stability (almost the same), price (the price for an impression taken with A-silicones is almost double). **Conclusions:** The dentist has to choose the proper material and correlate it with different clinical situations and techniques used in order to obtain the best results both for him and the patient.

Keywords: hydro-alginates, A-silicones, dimensional stability, time, price

INTRODUCTION

Choosing the right impression material and correct impression technique for a clinical situation, which can accurately reproduce the details and dimensions of the prosthetic field, has the most important role in manufacturing a good fixed denture.[1,2]

In Tîrgu Mureș, when clinicians wish to take a high-fidelity impression, the most frequent material used is condensation-cured silicone, followed by addi-

tion-cured silicones at a much lower rate, while hydro-alginates are almost never used.[3]

Hydro-alginates are the compatible combination of two materials necessary for taking the hydro-alginate impression (a reversible agar-agar hydrocolloid and an irreversible hydrocolloid, the alginate).[4] Agar is a hydrophilic colloid extracted from different types of seaweed. It is a sulfuric ester of linear polymer of galactose.[5] The viscosity and viscoelastic properties of the sol are very important. After liquefying, the material must be sufficiently viscous so that it does not flow out of the tray, and the viscosity should be adequate to record every detail of the prosthetic field. It is an irreversible hydrocolloid because it sets by a chemical reaction that results in the cross-linking of polymer chains. It has a complex composition, where the solutions of potassium and sodium salts of alginic acid react with calcium salt and produce an insoluble elastic gel.[5]

The purpose of our study is to demonstrate that the hydro-alginate impression, which is not really used in Romania, represents a very good alternative when trying to obtain high-fidelity impressions for fixed dentures at an affordable price. In order to achieve our goal, we carried out a comparative study between hydro-alginates and A-silicones. Modern A-silicone-based impression materials have remarkable elastic properties, they have a high tensile strength and can be stored for several weeks, being, therefore, ideal for use as precise impression material. We chose the A-silicones because when we talk about high-fidelity impressions, they represent the "gold-standard".[6]

When conducting the study, we analyzed parameters that reflect the advantages and disadvantages of the two types of materials: the time necessary to take the impression, the loss of material, the casting of the models, dimensional stability and costs.

In order to be as precise as possible, we had to use the right materials. For the hydro-alginate impression we used reversible hydrocolloid specially designed for this and A-class alginate, whereas for the impression taken with addition-cured silicones we used a combination of two consistencies: putty and light-bodied. As far as the impression techniques are concerned, we used the "wet-field technique" for the hydro-alginate impression and the "double-mix technique" for the A-silicones.[7,8]

The "wet-field technique" implies washing the preparations with warm water. The material from the syringe is being dropped only on the occlusal surfaces. The higher viscosity material from the tray will force the lighter-bodied material to penetrate into the sulcular area.[9]

The "double-mix technique" is a global mono-phasic impression that uses the same material in different consistencies. The putty silicone is inserted into a standard tray, then the light-bodied silicone is poured over in the sandwich version.[10,11]

MATERAL AND METHODS

We carried out an in vitro study in the laboratory of the Discipline of Tooth Morphology and Dental Prostheses Technology on two didactic models, an inferior acrylic dental arch with a molar preparation, and a model imitating two cavities: Black class I (cavity in pits or fissures on the occlusal surfaces of molars and premolars) and class II (cavity on the proximal surfaces of premolars and molars).

We also used orthodontic gypsum for casts, conditioning bath for the reversible hydrocolloid, digital micrometer (with an accuracy of 0.2 mm), chronometer, thermometer, regular metal partial trays (same size), tape as an adhesive for alginate, and varnish adhesive for the A-silicone putty.

When the reversible hydrocolloid has reached the optimal temperature and the alginate has been mixed (these two conditions have to be accomplished simultaneously), we can proceed to the actual impression. Directly from the syringe we apply material on the preparation on the occlusal surface, continuously, without detaching the syringe from the prosthetic field.

As soon as we are done with this operation, we load the tray with alginate and place it over the reversible hydrocolloid, applying a little pressure as well. The agar-agar hydrocolloid will harden due to the lower alginate temperature. When the alginate also hardens, we can remove the impression.

For the impression taken with A-silicones we had to follow several steps. First, we had to dose the putty silicone (base + accelerator). This combination is being kneaded in one hand for about 30 to 50 seconds, until the material becomes homogeneous and the color is uniform. After the preparation, we applied the putty into the tray. The next step involves the light-bodied A-silicone. We opted for the version in which the base and the accelerator are being stored in cartridges. A pistol and a special mixing tip with a spiral structure are needed to apply it, this way a perfect mixing can be obtained. This light-bodied A-silicone has to be being placed over the putty from the tray and then, the combination has to be applied onto the preparation with some pressure. The two types of silicones that are compatible will establish a powerful chemical bonding. This algorithm has been followed several times, until we made 10 hydro-alginate impressions and 10 A-silicone impressions for each model.

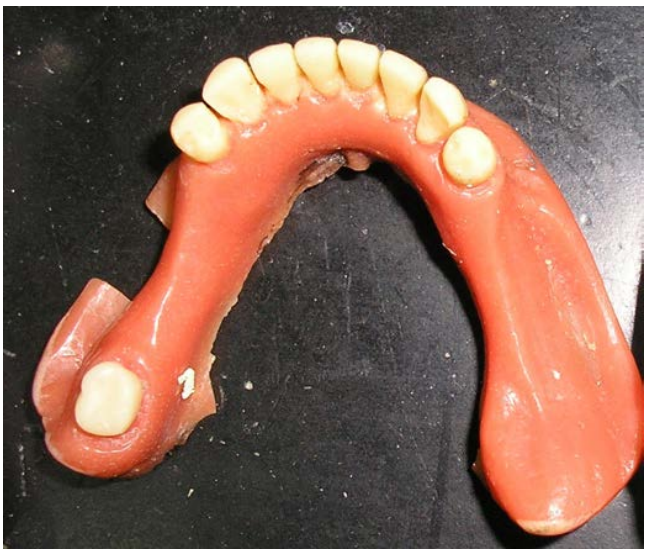

FIGURE 1. Inferior acrylic dental arch with a molar preparation

The removal of the tray involves a precise technique that is the same for both types of impression. We interrupted the marginal closure, and then, with a firm movement into the axis, we removed the impression. This technique is being known as "snap removal".

The next step was to cast the models. We used orthodontic gypsum according to the producer's indications. The gypsum needs approximately 5–8 minutes to harden apparently and 30–60 minutes to harden definitively.

After we casted the models, we carried out several measurements in fixed points (established before taking the impressions) on the gypsum models, with the digital micrometer. We compared the measurements with the dimensions of the acrylic models.

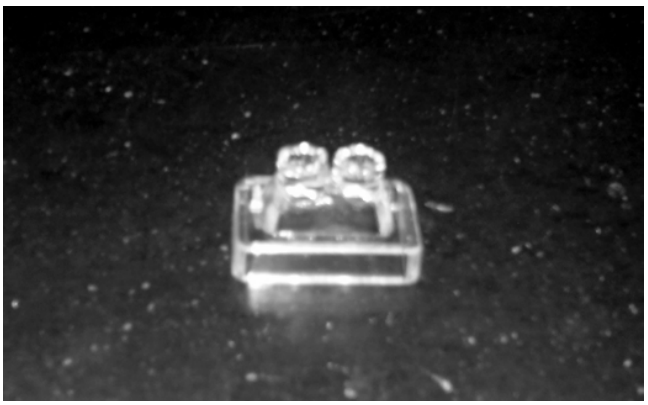

FIGURE 2. Replica of Black class I and II

With the help of an electronic scale and graded syringes we weighted the quantity of material used for each impression. This way we could also estimate the loss of material and the price of each impression.

RESULTS

The time necessary to take the impression

The dosage, the preparation of the impression materials (alginate with normal hardening time and reversible hydrocolloid), the loading of the tray, the moistening of the model with warm water took 2 minutes for both model 1 and 2. The necessary time for the hydro-alginate impression of model 1 and 2 also took 2 minutes (± 10 seconds).

The dosage, the preparation of the A-silicone putty + light-bodied silicone (both with normal hardening) took 2

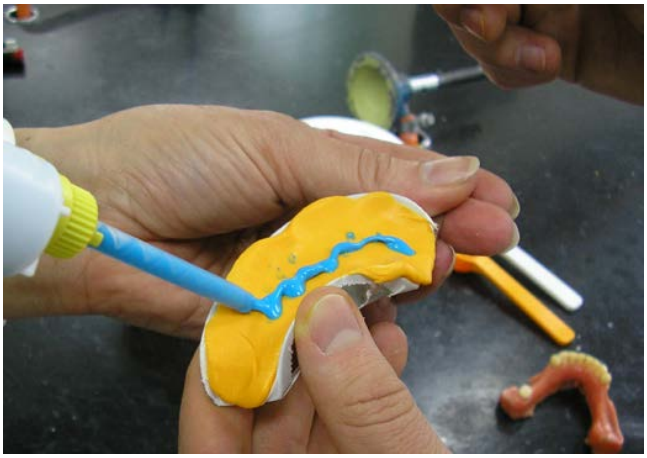

FIGURE 3. The application of the light-bodied A-silicone on top of the putty

FIGURE 4. Different measurements performed with the digital micrometer

TABLE 1. The values obtained after taking measurements in a fixed point

Type of model	Standard dimensions (mm)	Dimension of the 'hydro-alginate' cast	Dimension of the 'A-silicone' cast
Cavitary model	4.36	4.35	4.355
Prepared acrylate tooth	5.83	5.82	5.825

minutes for model 1 and 2 as well. The time needed for the A-silicone impression of both model 1 and 2 was 8 minutes (± 10 seconds).

The removal of the impression

None of the impressions created problems when we had to remove them.

Loss of material

In the case of hydro-alginates, if the alginate is dosed correctly, there is no loss of material. For the A-silicones, with every impression the material that remains in the tip of the pistol is being lost, more precisely 1.5 ml of light-bodied silicone.

Dimensional stability

Measurement values are presented in Table 1.

Price

The price of an A-silicone impression is almost double compared to a hydro-alginate impression.

DISCUSSION

By analyzing different parameters, we could compare the hydro-alginate impression with a more popular impression material, the addition-cured silicones. Surprisingly, most of the times, the hydro-alginate impression behaved better than the "gold-standard" impression.

In the phase of imprinting, we measured time from the moment we inserted the tray until the material hardened. As our results have shown, there was quite a large difference here, approximately 6 minutes. In other studies this time was considered to be a loss of money.[9] In our study however, we analyzed the two parameters (time and money) separately.

When we had to remove the impressions, none of them created problems, because we used the specific "snap removal" technique. However, a difference appeared while preparing the trays. For the hydro-alginate impression it was suffice to use some adhesive bands, whereas for the A-silicone impression a special adhesive is recommended, which eliminates the risk of compromising the impression when it is being removed. Purchasing this special adhesive means a higher overall price, a disadvantage compared to the hydro-alginates.

As we mentioned previously, if we dose the alginate correctly and the reversible hydrocolloid is being dropped from syringes, the loss of material in the case of hydro-alginates is null. We cannot say the same about A-silicones. There is no loss when preparing the putty, but there are a few drawbacks as far as the light-bodied silicone is concerned. For a better dosage, we used A-silicone in cartridges and we applied it from a pistol with a tip that insured a perfect homogenization and no air inclusions.[10] The disadvantage of this tip is that it cannot be used for more than one impression, and its volume of 1.5 ml represents a loss.

Rebecq Vincent carried out a study called 'Comparative study of the capacity of reproducing details between hydro-alginates and three other impression materials'.[12] In this study, he followed the latest tendencies of AFNOR (Association Française de NORmalisation) and conducted a public inquiry regarding the accuracy of reproducing details by impression materials. His findings state that an impression material can be considered accurate if it reproduces details with a precision of 15 μm instead of the previous standard of 20 μm. The results of his study show that both A-silicones and hydro-alginates are excellent impression materials in fixed dentures, and their fidelity is in the range of 15 μm. We reached the same conclusion when we studied dimensional stability. For both model 1 and 2, we found a difference of 10 μm in the case of hydro-alginates and 5 μm in the case of A-silicones. In both cases the values were within the 15 μm range, showing the high precision of the two impressions in reproducing details.

No matter how many advantages or disadvantages a material has, if it can reproduce the details of the prosthetic field in an accurate way, there comes a time when we also must think about its price. In a market that is growing bigger and bigger, the new trend is to obtain the best results with the most affordable product. This means we always should take into account the quality/price ratio. After we

have measured the quantity of the material we used, we calculated the price of one impression based on the price of the entire quantity of material and the lost amount, and we concluded that an A-silicone impression costs twice as much as a hydro-alginate impression. In this regard, the hydro-alginate impression stands out clearly from the A-silicone. If we analyze the quality/price ratio, at a similar quality a hydro-alginate impression is almost two times more affordable.

The most similar study with ours is the one lead by Gateau and Blanchet.[13] They describe and analyze the hydro-alginate impression, how and when to use it, its advantages and disadvantages. In 1988, the necessary time for taking the impressions: 26 minutes for the silicones, 13 minutes for the reversible hydrocolloid and 10 minutes for the hydro-alginates. At a distance of 28 years, we can see that the time of impression has decreased a lot since then, but the hydro-alginate impression has better parameters compared to the other materials.

Another study that needs to be taken into consideration is the one carried out by Appleby.[14] This is one of the first studies involving the hydro-alginate impression. He mentions that the biggest advantage of the alginate-reversible hydrocolloid combination is that the irreversible hydrocolloid from the tray simplifies the procedure, and the reversible component gives the impression a higher capacity of reproducing details. There are several other studies that recognize the efficiency of the hydro-alginate impression; a good example would be Dahl's study.[15]

Errors may occur at every level, but we tried to limit them as much as possible. Generally, every maneuver executed by a human can become a source of error, but after years of practice their number is smaller. Our purpose was to demonstrate that the hydro-alginate impression, an impression that isn't really used in Romania, represents a reliable alternative for high fidelity impressions for fixed dentures. Our goal was reached by comparing this impression's properties with the ones of A-silicone. Unfortunately, practitioners have two choices when they wish to take a high fidelity impression: they either use an affordable material with poor properties or they use an expensive material with great advantages. We demonstrated that by using the hydro-alginate impression we can obtain a high fidelity impression at an affordable price.

The only difficulty in carrying out our study was the fact that we could not obtain the reversible hydrocolloid from our country, we had to purchase it from abroad.

The need for our study cannot be doubted, since other studies that involve the hydro-alginate impression are quite old. The properties of hydro-alginates remain topical, some of them becoming superior to the ones from the past.

CONCLUSION

In this study we compared two types of impression materials and we came to some interesting conclusions. Once the impression technique is mastered, using hydro-alginates is very simple and there is no need for additional equipment. The time of impression when using hydro-alginates is shorter and they are almost two times more affordable than A-silicones. We concluded that the combination of reversible hydrocolloid and alginate has other advantages such as dimensional stability and no loss of materials, and it can also be used on a wet prosthetic field. Unfortunately, hydro-alginates are not very popular in our country and there are no options for their purchase.

CONFLICT OF INTEREST

Nothing to declare.

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