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Comparison of Tearing strength and Dimensional Stability of Alginate Impression Material Mixed with Water and Chlorhexidine

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مقارنة قوة التمزق والاستقرار الأبعادي لمادة اتخاذ القالب بالألجينيت المخلوطة بالماء والكلورهيكسيدين.

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ABSTRACT

Background:

An irreversible hydrocolloid impression material combined with two different doses of chlorhexidine solution is tested for dimensional change and tearing strength. The aim of this study is to evaluate the impact of adding chlorhexidine with 2 different available concentrations on alginate impression material.

Materials and Methods:

According to the manufacturer's instructions, the irreversible hydrocolloid specimens is made and divided into 3groups (Group 1 is mixed with tap water as a control group, Group 2 is mixed with 0.12 chlorhexidine, and Group 3 is mixed with 0.2 chlorhexidine). Testing is done on the change in dimensions and the tearing strength.

Results:

Lesser dimensional change is observed at group two and is non-significant, and the group three is significantly more dimensionally stable when compared with group one, tearing strength of group one and two is nearly the same while the group three is more resistant to tear and the difference is significant

Conclusion:

The dimensional stability and tearing resistance of chlorhexidine self-disinfecting irreversible hydrocolloid impression material may vary greatly.

Key words:

Alginate, dimensional stability, tearing strength, chlorhexidine

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INTRODUCTION

Alginate impression material is commonly used in dentistry to make preliminary impressions of the patient's teeth and oral tissues. For diagnostic impressions, alginate seems to be the material of choice since it is affordable, hydrophilic, accurate, and simple to manipulate. [1],[2] Low-cost polyvinyl siloxane (PVS) impression materials, or "alginate replacements," have been developed as alternatives to conventional alginate thanks to modern in material refining procedures. Producing research and orthodontic models, are creating provisional crowns and bridges and making major impressions for detachable prosthodontics may all be done with these materials. Powdered dental alginate is combined with water in precise proportions by the manufacturer [3],[4] – Dental alginate with each commercial product, you will get a scoop for the powder as well as a graduated beaker for the water [5]. Some goods are thick and viscous, while others are thinner and less viscous. This is due to the fact that the powder/water proportion varies from company to company, results in a noticeable difference in the fluidity of the mix. This might have an effect on the set's alginate [5] characteristics. This hydrocolloid material's low tear strength necessitates a very high tear strength. Any dental imprint substance must also reproduce fine details, which is a necessity [6]. While chlorhexidine is often added to alginate to provide antimicrobial properties, there are other materials that can be used to improve the physical properties of alginate. Some of these materials include:

1. Calcium sulfate: Adding calcium sulfate to alginate can enhance its setting time and improve the overall strength of the impression material. It helps to create a more rigid and less brittle impression, reducing the risk of tearing or distortion during removal.

2. Potassium sulfate: Similar to calcium sulfate, potassium sulfate can be used to modify the setting time and strength of alginate. It provides a denser and stronger impression, making it more resistant to deformation during removal.

3. Silicone-based additives: Some silicone-based materials can be incorporated into alginate to enhance its physical properties. These additives can improve the tear strength, elasticity, and flexibility of alginate impressions. They can also help reduce the surface stickiness of alginate, making it easier to handle and manipulate. [3],[4]

The most important factors that affect the tearing strength of alginate impression material are; composition, water to powder ratio, mixing technique, setting time, storage conditions, thickness of the impression and manipulation during removal [11].
Our research is done to evaluate wether there will be any effect of mixing the two available concentrations of chlorhexidine with two different concentrations with alginate impression material and compare the results.

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MATERIALS AND METHODS

A total of 60 alginate impression samples are used in the study [41], with 20 samples mixed with tap water as group 1, 20 samples mixed with 0.12 concentration of chlorhexidine mouth wash as group 2, and another 20 samples mixed with 0.2 concentration of chlorhexidine mouth wash as group 3. The liquid/powder ratio was determined in accordance with the manufacturer's recommendations. The alginate impression material has been thoroughly blended together. The chlorhexidine indicates by the manufacturer was used to combine group 2 and 3 of the specimens in this investigation. All the specimens are kept in room temperature during test and the test is done directly after setting of the samples and after 15 minutes and after 30 minutes for all the specimens.

All the results are analyzed by using the (SPSS) software program.

2.1 Dimensional stability test

Alginate impression materials are evaluated in accordance with the American Dental Association's (ADA) standard number 19. As a mold for a dental impression, stainless steel equipment with a metal block and ring engraved with transverse and longitudinal lines is used. Fig. 1:

Figure 1. Specification number Nineteen of the American Dental Association was used.

There was a total of 30 specimens in the study. 30 samples were divided into three groups, each of which had 10 samples for the control group and for each of the two concentrations of chlorhexidine with alginate impression material (Alginplus, Italy) shown in figure 2. For ease of separation, the metal block's edges were coated with the separating media before the alginate imprint material was applied. A one-kilogram weight was put on top of a glass slab to replicate the pressure of a palm on a tray [24]. The alginate impression materials utilize in this investigation have a suggested setting time of three minutes. The dimensional stability is measured using a ruler under a USB microscope after setting time, then 15 minutes after setting time, and thirty min after setting.

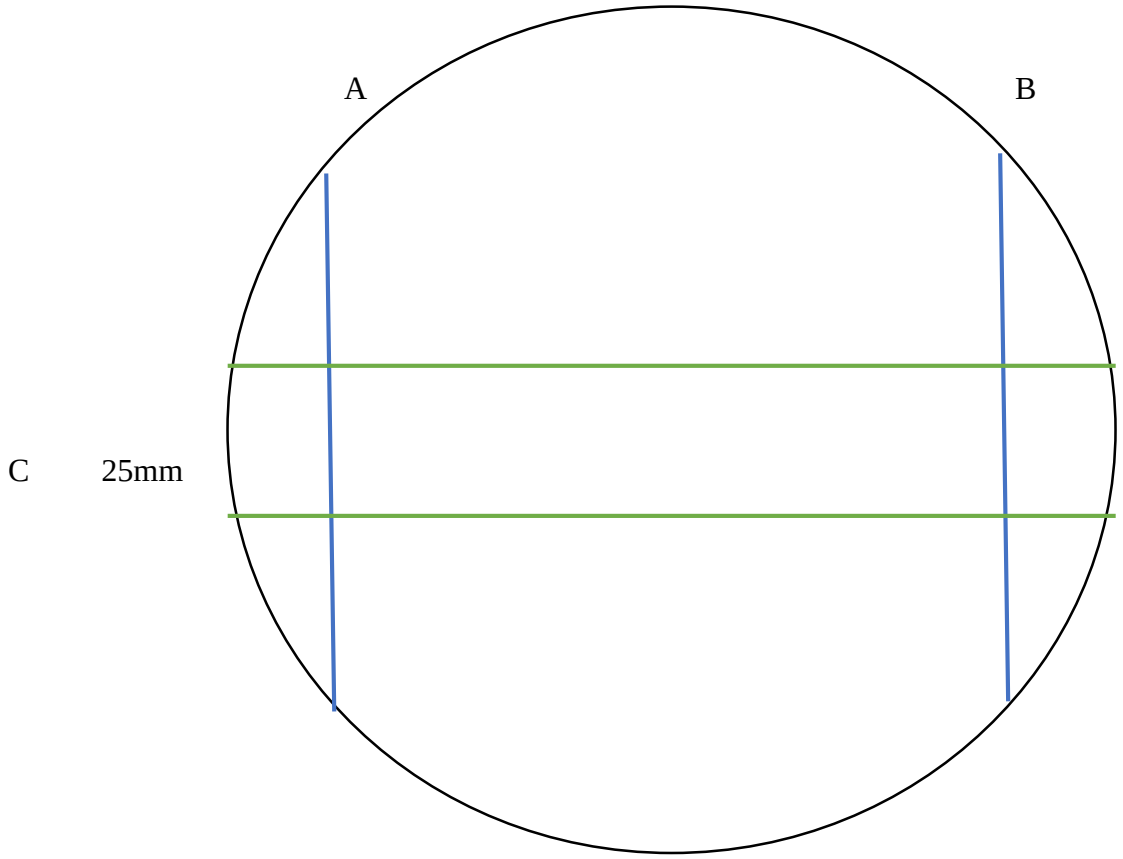

Figure 2: Line C, which measured 25mm between A and B, is shown in this diagram of the metal plate apparatus used in this investigation.

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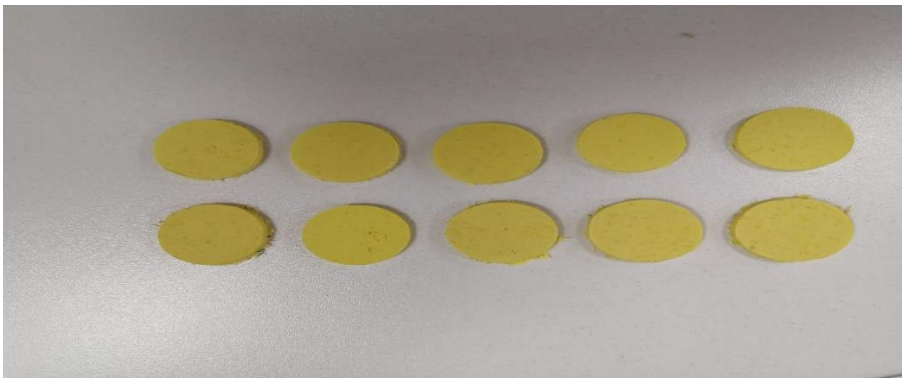

Figure 3: Samples for each group

2.2 Tearing strength test

For the tear strength measurement, the alginate mixture was placed into a V-shaped Teflon mold that had been specifically produced by the American Society for Testing and Materials (ASTM). For the length, breadth, and thickness, the mold is 98 * 20 * 4. Fig. 4.

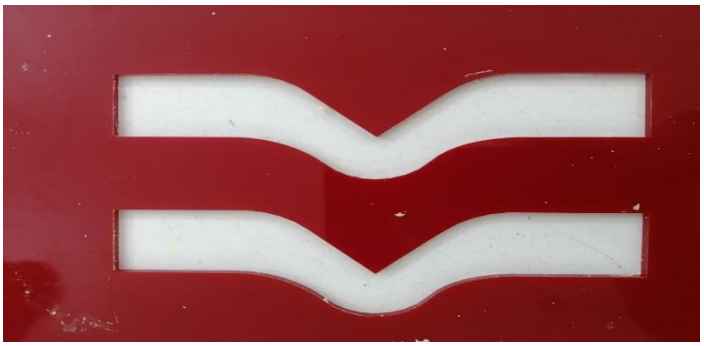

Figure 4: Mold used in the study

There is a total of 30 specimens in the study. There were 30 samples in all, divided into three subgroups, each of which included ten samples for each concentration of chlorhexidine in alginate (Alginplus, Italy) (figure 5). Each group has ten specimens prepared for testing the tear strength. The edges of the mold were coated with separating media before the alginate impression material was placed to the mold. A one-kilogram weight was put on top of a glass slab to replicate the pressure of a palm on a tray [24]. The alginate impression materials utilized in this investigation have a suggested setting time of three minutes.

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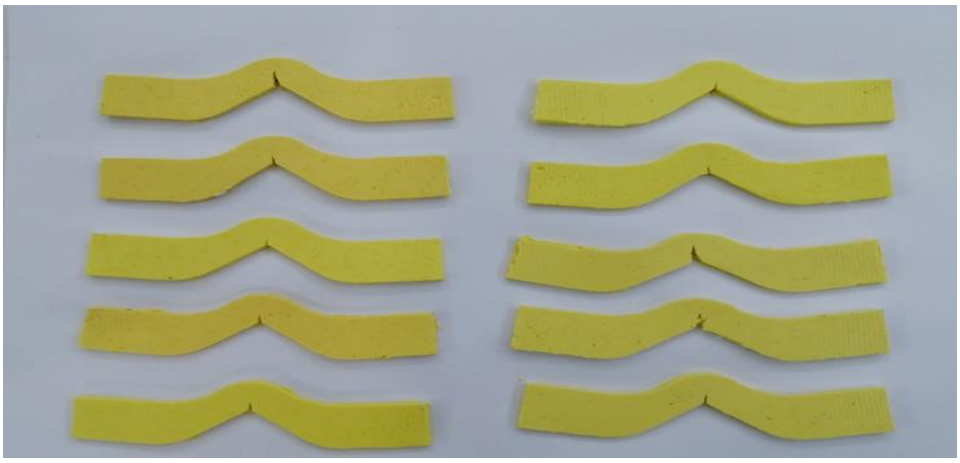

Figure 5: Samples for each group

It is then fastened in a testing machine (in this case from Taiwan) by means of a pneumatic clamp once the specimen was set (fig 6). Before the test started, the fixture is modified to ensure that the sample are nor in compression nor tension at any point throughout the test. A cross - head speed of 5 mm/min was used to keep the specimens under tension until failure [33].

Figure 6: Universal testing machine used in the study with sample

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RESULTS AND DISCUSSION

3.1 Dimensional accuracy

By Using the (SPSS), the results were analyzed. Dimensional stability was assessed for each group immediately after setup time, 15 minutes later, and then 30 minutes after that. No significant difference was found between groups 1 and 2, however after 30 minutes, there was a significant difference between the study group and group 2. Group 3 is found to be significantly different from groups 1 and 2, according to the findings of this research. Tables 1,2 and 3 are included.

Table 1. Control group alginate mixed with tap water

Sample	Length after setting time / mm	After 15 minutes	After 30 minutes
1	25	24.5	**]24.25**
2	25	24.5	**24.23**
3	25	24.5	**24.22**
4	25	24.5	**24.25**
5	25	24.5	**24.25**
6	25	24.5	**24.20**
7	25	24.5	**24.30**
8	25	24.5	**24.25**
9	25	24.5	**24.28**
10	25	24.5	**24.25**

Table 2. Group 2 alginate and 0.12 chlorhexidine mouth wash

Sample	Length after setting time / mm	After 15 minutes	After 30 minutes
1	25	24.5	**24.5**
2	25	24.5	**24.5**
3	25	24.5	**24.5**
4	25	24.5	**24.5**
5	25	24.5	**24.5**
6	25	24.5	**24.5**
7	25	24.5	**24.5**
8	25	24.5	**24.5**
9	25	24.5	**24.5**
10	25	24.5	**24.5**

Table 3. Group 3 alginate mixed with 0.2 chlorhexidine mouth wash

Sample	Length after setting time / mm	After 15 minutes	After 30 minutes
1	25	25	**25**
2	25	25	**25**
3	25	25	**25**
4	25	25	**25**
5	25	25	**25**
6	25	25	**25**
7	25	25	**25**
8	25	25	**25**
9	25	25	**25**
10	25	25	**25**

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3.2 Tearing strength

After establishing a period for each group, the group's tear strength is instantly measured. Differences between the groups are found in this study's findings. For groups 1 and 2, the average ripping force was (1.2 N = 0.0296 MPa), whereas for groups 3 it was (1.5 N = 0.038 MPa). Tables 4 through

Table 4. Control group

Sample	Tearing force / N	Tearing force / MPa
1	1.26	**0.031**
2	1.1	**0.027**
3	1.12	**0.027**
4	1.2	**0.029**
5	1.24	**0.03**
6	1.2	**0.029**
7	1.28	**0.031**
8	1.29	**0.031**
9	1.05	**0.025**
10	1.28	**0.031**

Table 5. Group 2 alginate mixed with 0.12 chlorhexidine

Sample	Tearing force / N	Tearing force / MPa
1	0.75	**0.018**
2	0.78	**0.020**
3	0.71	**0.015**
4	0.81	**0.021**
5	0.76	**0.019**
6	0.75	**0.018**
7	0.74	**0.017**
8	0.73	**0.015**
9	0.70	**0.010**
10	0.71	**0.015**

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Table 6. Group 3 alginate mixed with 0.2 chlorhexidine

Sample	Tearing force / N	Tearing force / MPa
1	1.57	**0.038**
2	1.50	**0.030**
3	1.53	**0.034**
4	1.58	**0.039**
5	1.57	**0.038**
6	1.57	**0.038**
7	1.55	**0.036**
8	1.56	**0.035**
9	1.60	**0.040**
10	1.57	**0.038**

4. DISCUSSION

Dimensional stability and tearing strength are important properties to consider when evaluating alginate impression materials mixed with chlorhexidine at different concentrations. Alginate is a widely used dental impression material, and chlorhexidine is often added to the mix to provide antimicrobial properties, reducing the risk of contamination during making the impression [10]. Dimensional stability refers to the ability of an impression material to maintain its original shape and dimensions over time [25]. It is a crucial factor as accurate impressions are essential for well-fitting dental restorations. The addition of chlorhexidine to alginate impression material has shown promising results in improving its dimensional stability. Chlorhexidine, a widely used antimicrobial agent in dentistry, brings several beneficial effects to the mixture. Firstly, chlorhexidine exhibits potent antimicrobial properties, inhibiting the growth of bacteria and fungi within the material. By reducing microbial degradation, chlorhexidine helps preserve the integrity of the impression and minimizes dimensional changes caused by microbial activity. Furthermore, the addition of chlorhexidine to alginate can potentially reduce water absorption. Alginate is known to absorb water, leading to expansion and distortion. However, chlorhexidine may modify the surface properties of alginate, resulting in decreased water absorption. This reduction in water absorption contributes to improved dimensional stability by minimizing the potential for expansion and distortion of the impression material [12].

In addition, chlorhexidine has been reported to exhibit crosslinking effects on certain materials. The interaction between chlorhexidine and the alginate molecules can lead to enhanced crosslinking, strengthening the overall structure of the material. This increased crosslinking

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contributes to improved dimensional stability by providing better resistance against deformation and maintaining the size and shape of the impression over time [15].

Adding chlorhexidine to alginate can potentially influence the dimensional stability of the material. At a lower concentration of chlorhexidine (0.012%), the dimensional stability of the alginate impression material might remain relatively unaffected after 15 minutes, but after 30 minutes the dimensional change of the control group was more and significant and the group 1 was changed less. Chlorhexidine at this concentration is more likely to act as an antimicrobial agent without significantly altering the physical properties of alginate. As a result, the impressions made with this mixture may retain their accuracy and integrity after 15 minutes [15].

At a higher concentration of chlorhexidine (0.2%), there could be some impact on the dimensional stability of the alginate impression material. Higher concentrations of chlorhexidine might interfere with the alginate's setting reaction, leading to increasing in the material's setting time and in turn the alginate impression will remain in its dimension for longer time. As seen in the results, there was significant difference between the control group and the group 3 after 15 and 30 minutes.

In comparing the group 2 and 3, there was nonsignificant difference between both after 15 minutes but significant difference between them after 30 minutes.

The addition of chlorhexidine to alginate impression material holds the potential for improvement in tearing strength, which refers to the material's resistance against tearing or fracture. Chlorhexidine, known for its antimicrobial properties and mechanical reinforcement capabilities, can contribute to enhanced tearing strength when mixed with alginate. One way chlorhexidine may improve tearing strength is through its reinforcement effect. Studies have reported that chlorhexidine can enhance the mechanical properties of various materials. When incorporated into alginate, chlorhexidine acts as a reinforcing agent, strengthening the structural integrity of the material. This reinforcement effect can enhance the material's resistance to tearing and increase its overall durability.

Moreover, chlorhexidine's presence in the alginate mixture may lead to improved cohesion between the alginate particles. By enhancing the bonding forces between the particles, chlorhexidine contributes to a more cohesive material. This increased internal cohesion results in a stronger resistance to tearing, as the material becomes less prone to fracture or separation under stress. The concentration of chlorhexidine used in the mixture is a crucial factor influencing the extent of improvement in tearing strength. Additionally, the specific formulation of the alginate impression material and the experimental conditions play a role in determining the magnitude of the effect. Therefore, it is important to consult the specific studies and experimental findings that support the claim of improved tearing strength when alginate is mixed with chlorhexidine, considering factors such as concentration, formulation, and experimental methods used [12].

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Tearing strength refers to the ability of an impression material to resist tearing or fracturing during removal from undercuts or narrow areas of the oral cavity. Alginate impressions with sufficient tearing strength are less likely to distort or tear during removal, ensuring better accuracy [13].

At a lower concentration of chlorhexidine (0.012%), the tearing strength of the alginate impression material might remain comparable to that of standard alginate. Since the chlorhexidine concentration is relatively low, it is less likely to alter the material's physical properties significantly.

At a higher concentration of chlorhexidine (0.2%), there could be some impact on the tearing strength of the alginate impression material. Higher concentrations of chlorhexidine might affect the alginate's inherent strength, making the impressions less susceptible to tearing, especially in areas with undercuts or when removing the impression from the mouth as shown in the results.

CONCLUSIONS

After seeing the results, can only draw the conclusion that combining alginate impression material with various amounts of chlorhexidine helps prevent shrinking and also improves tearing strength within the restrictions of this investigation.

Conflict of interests

There are non-conflicts of interest.

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الخلاصة

مقدمة:

تم اختبار مادة القالب الهيدروكولويدية اللاقابلة للانعكاس مع جرعتين مختلفتين من محلول الكلورهيكسيدين للتغير الأبعادي وقوة التمزق.

طرق العمل:

وفقًا لتعليمات الشركة المصنعة، تم تحضير عينات الهيدروكولويدية اللاقابلة للانعكاس وتقسيمها إلى مجموعات (المجموعة 1 تم خلطها مع ماء الصنبور كمجموعة ضابطة، المجموعة 2 تم خلطها مع 0.12% من الكلورهيكسيدين، والمجموعة 3 تم خلطها مع 0.2% من الكلورهيكسيدين). تم إجراء الاختبارات على تغير الأبعاد وقوة التمزق.

الاستنتاجات:

: يمكن أن يختلف استقرار الأبعاد ومقاومة التمزق لمادة القالب الهيدروكولويدية اللاقابلة للانعكاس المعقمة ذاتيًا بالكلورهيكسيدين بشكل كبير.

الكلمات المفتاحية:

الجينيت، ثبات الأبعاد، قوة التمزق، الكلورهيكسيدين