

Evaluation of some mechanical properties of dental alginate impression materials after fluoride addition

Israa M. Hummudi, PhD*

*Instructor , College of Health and Medical Technologies

المستخلص

الهدف: الهدف من هذه الدراسة هو تقييم بعض الصفات الميكانيكية مثل وقت التصلب والقوة الأنضغاطية لمادة طبعة الألجنيت السنية بعد إضافة الفلورايد بتركيز مختلفة.

المنهجية: تم تحضير 60 عينة من مادة الألجنيت وتم تقسيمها إلى مجموعتين حسب الاختبار (30 عينة لكل اختبار) ثم تم تقسيم كل مجموعة إلى ثلاثة مجاميع ثانوية. مجموعة أ: تضم 10 نماذج من مادة الألجنيت تم خلطها مع الماء المقطر. مجموعة ب: 10 نماذج من مادة الألجنيت تم خلطها مع 100 ppm من محلول الفلورايد. مجموعة ج: 10 نماذج من مادة الألجنيت وتم خلطها مع 2% من فلوريد الصوديوم.

النتائج: أظهرت النتائج أن إضافة مادة الفلورايد قد تسبب في تأخر وقت التصلب وقد تقلل من القوة الأنضغاطية لمادة الألجنيت. **التوصيات:** يمكن الاستنتاج أن إضافة مادة الفلورايد قد يؤثر على الصفات الميكانيكية لمادة الألجنيت بهذه التراكيز. يفتتح الكلمات: الألجنيت، وقت التصلب، الفلورايد، القوة الأنضغاطية، فلوريد الصوديوم.

Abstract:

Objective: Fluorid-containing dental alginate impression materials can exert a considerable reduction in enamel solubility. The objective was to evaluate the effect of fluoride addition on the setting time and compressive strength of alginate impression materials.

Methodology: 60 samples were constructed from alginate impression material (30 samples for setting time test and 30 samples for compressive strength test). Specimens of each test divided into three subgroup. Group A: 10 specimens of alginate were mixed with distilled water [control], Group B: 10 specimens of alginate were mixed with 100-ppm fluoride and Group C: 10 specimens of alginate were mixed with 2% Naf.

Results: the result of setting time test showed that addition of 2% Naf to alginate impression materials were delayed the setting reaction while the results of compressive strength test showed that high mean values were obtained from control group while group mixed with 2% Naf had lower compressive strength.

Recommendation: it can be concluded that addition of 100-ppm fluoride were affect on the properties of alginate impression materials while addition of 2% Naf was deteriorated the properties of alginate impression materials. So recommends the effect of fluoride addition in other concentration.

Key words: alginate, setting time, fluoride, compressive strength, Naf

Introduction:

The caries preventive effect of fluoride is mainly attributed to the effects on demineralization/ remineralization at the tooth and oral fluid interface. Sub ppm levels of fluoride in saliva are effective in shifting the balance from demineralization, leading to caries to remineralization. This is attributed fluoride enhanced precipitation of calcium phosphates, and the formation of fluorhydroxyapatite in the dental tissues⁽¹⁾.

A predominant part of the cariostatic activity of fluoride is a function of its concentration in the fluid environment around the tooth. The fluoride exposure results in a slightly elevated steady-state level of fluoride in the oral fluids, primarily in saliva and plaque fluid. Following fluoride intake, fluoride remained in the oral cavity is diluted by the saliva pool. It is well established that plaque, after fluoride exposure, becomes a fluoride reservoir, which stores for some time and releases fluoride⁽²⁾.

A variety of fluoride releasing products designed for topical use is currently available. Following their use, varied amount of fluoride is systemically absorbed depending on the fluoride concentration and the manner of its use⁽³⁾.

The addition of fluoride compound in dental alginate impression materials was shown to produce a firmer and more definite set, and the surface condition of the stone cast improved^(1,4).

It is well known that some commercial alginate

impression materials contain high concentration of fluoride, part of which is readily transferred to the surface of tooth, saliva and plaque fluid after impression taking. Fluoride containing alginate impression materials have been shown to exert a considerable reduction in enamel solubility⁽⁵⁾.

The use of alginate-based materials as a vehicle for topical application of fluoride offers a valuable means of increasing the enamel resistance against acid demineralization^(6, 7).

Little is known on the fluoride release from alginate impression material in which fluoride was added to deliver effective level of fluoride, and the effect of fluoride addition on the properties of alginate materials⁽⁸⁾.

The present study was aimed to evaluate the effects of fluoride addition on the setting time and compressive strength of dental alginate impression materials.

Materials and Methods:**General condition of testing specimens**

The preparation of test specimens and test procedures was conducted at $23.0 \pm 2^\circ\text{C}$ and relative humidity $50 \pm 10\%$. The alginate in a moisture resistant container, was conditioned at a temperature of 23.0°C for at least 10 hours prior to testing.

Metal pattern preparation

Stainless steel metal pattern was constructed according to the ANSI / ADA specification no. (18) 1992 with a dimension of (6mm in diameter and 2mm in height) Fig (1).



Fig (1) stainless steel metal pattern

Testing groups:

Sixty specimens (60) were constructed from alginate impression materials and were divided into two main groups according to the method of testing (30 specimens for setting time test and 30 specimens for compressive strength test). Then each test subdivided again to three subgroup each group consist of 10 specimens according to the methods of fluoride addition as follows (1):

Group A: 10 specimens of alginate mixed with distilled water (control).

Group B: 10 specimens of alginate mixed with 100-ppm fluoride solution.

Group C: 10 specimens of alginate mixed with 2% Naf solution.

Proportioning and mixing of alginate:

Experimental alginate powder was measured in grams by using electronic digit balance, Fig (2) and water was measured in millimeter by using graduated cylinder. Then alginate impression powders were mixed with glass ball for half an hour at 160 rpm to obtain homogeneous mixture. Then the mixed powder was sieved with no.140

standard sieve.

Mixing ratio was 5 gm of alginate powder with 12 ml of water or fluoride solution according to the ISO specification 1563 for hydrocolloid impression materials.

Alginate was hand mixing for time recommended by manufacturer which was controlled by a timer, and the method was kept almost constant with all mixing. Initially, the mixing was done slowly so that the alginate powder was thoroughly wetted and none of the powder lost from the bowl. It was then followed by energetic 2 spatulation when the material was worked against the side of the bowl. Until homogenous mixture was obtained, then placed immediately inside the mold until the material has exuded on the top of the mold, a flat glass was pressed on the top of the mold to remove the excess material (11). Fig(3).



Fig (2) electronic digit balance



Fig (3) specimen of alginate impression material

Compressive strength test

The process of measuring the compressive strength by using compressive strength testing machine. Fig (4). Specimens prepared as specified ADA/ No. (18)1992, specimen placed in cylindrical plate. Then hydrolyic press was press on it and subjected to load calculated 10 produce stress 100gm /cm². The force applied was varied from 10 N-1000N according to the specimen. Force applied in this study was

100N as shown in formula:

$$C = F / A$$

C: compressive strength

F: force

A: area



Fig (4) compressive strength testing machine

Setting time test:

Setting time was measured according to the ANSI / ADA specification No 18. After filling the mold with mixed material, an end of poly (methylacrylate) test rod was placed into momentary contact with the unset

Results:

Descriptive statistics of setting time test showed that the mean values for the

material. The test rod was withdrawn and was cleared of any material left from the contact. The contact / withdrawal steps were repeated until the rod separated cleanly from the material.

control group was 2.5minutes. Fluoride 100 ppm was 3.8minutes and for Naf 2% were 5 as shown in table (1).

Table 1. Descriptive statistics of control and tested groups for setting time test / minutes.

Groups	Number	Mean	Stdandard Deviation	Range	
				Minimum	Maximum
Control	10	2.5 min	0.49	2	2.6
Fluoride (100pm)	10	3.8min	0.44	3	4
Naf 2%	10	5min	0.37	4.8	5.6

Paired Samples student (t.test) observed a highly significant differences $p < 0.01$ between control, fluoride (100 ppm) and Naf 2% as shown in table (2) .

Table 2. t-test between control and test groups

Tested groups	t-test	p-value	C.S
Control – fluoride	2.735	$P < 0.01$	H.S
Control – Naf	10.253	$P < 0.01$	H.S

P value = probability value , C.S.=Comparative Significant

Compressive strength test

Descriptive statistics of compressive strength test showed that the mean values

for the control group was 3.44, fluoride 100 ppm was 2.82 and for Naf 2% was 1.05 as shown in table (3) Fig (5).

Table 3. Descriptive statistics of control and tested groups for compressive strength test mg /cm²

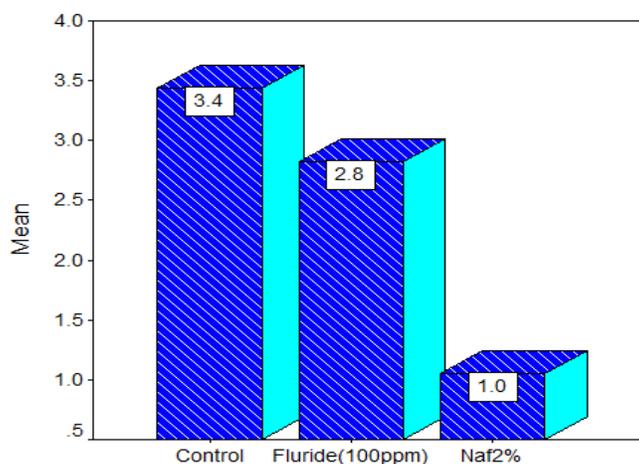
Groups	Number	Mean	Standard Deviation	Range	
				Minimum	Maximum
Control	10	3.44 mg / cm ²	0.27162	3.2	4
Fluoride (100pm)	10	2.82 mg / cm ²	0.48027	2.2	3.5
Naf 2%	10	1.05 mg / cm ²	0.4719	0.5	1.7

Paired Samples student (t.test) observed a highly significant differences $p < 0.01$ between control, fluoride (100 ppm) and Naf 2% as shown in table (4).

Table 4. t-test between control and test groups

Tested groups	t-test	p-value	C.S
Control – fluoride	3.230	P< 0.01	H.S
Control – Naf	12.390	P< 0.01	H.S

P value = probability value , C.S.=Comparative Significant

**Fig (5):** Bar chart showed mean values between testing group.mg/cm²**Discussion:**

Fluoride compounds are fundamental ingredients of alginate impression material. Fluoride salts accelerate the from 0.86% to 3.5%, whereas the fluoride content of the most popular topical fluoride gels was 1.23% or less ⁽⁸⁾.Therefore, an unexpected source of fluoride to which many dental patients are exposed is alginate impression procedure. The high concentrations of fluoride in alginate impression materials can result in substantial elevation of fluoride in body fluid and surface enamel ⁽¹²⁾.

Addition of fluoride may be an effective method of fluoride delivery. Moreover, intimate contact with alginate impression

material and tooth may enhance the fluoride transfer compared with fluoride gel, which are too flowable to contact intimately with the tooth ⁽¹⁾.

In the present study addition of fluoride into alginate impression materials resulted in a highly differences between specimens mixed with distal water (control) and specimens mixed with fluoride (100ppm,2% Naf) in the compressive strength test this may be due to strong activity of fluoride ions and their affinity to Ca ions, fluoride solutions decomposed silicate cement, very likely by reversing the original setting reaction ^(1,13).Moreover mixing alginate with 2%Naf solution instead of water

,setting was delayed from 2.5 to 5 minutes .As this, fluoride may have some destructive effect on the alginate impression material. Hardened piece of alginate impression materials were exposed to 2% NaF solution and it was found within a few minutes liquefaction of material was observed. This finding is in agreement with the works of Kun Lee et al 2004.

It can be concluded that addition of 100-ppm fluoride solution resulted in minor changes in compressive strength of alginate impression materials. While addition of 2% NaF solution resulted in major changes in compressive strength of alginate impression material and delayed setting time.

Recommendation:

1. Effect of fluoride addition on the properties of elastomeric impression materials.
2. Effect of fluoride addition in other concentration.

References:

- 1.Kuen-Lee Y, Soon Lim B, We Kim CH. Effect of fluoride addition on the properties of dental alginate impression materials .J Mat.Science.2004;15:219-224 .
- 2.Ekstrand J and Olive A.Dental impression material useful for making molds of fossil.Acta Odontol.Scand.1999;57:33-39.
- 3.Frey G.and Powers J.Effect of mixing method on mechanical properties of alginate

impression material . J prosthet Dent.2005; 14(4):221-225.

- 4.Murata H,Kawamura M,Hamad T,Chimora H,and Nikawa H.Physical properties and compatibility with dental stones of current alginate impression material. J.Prosthet Dent.2005;14(4):221-225.
- 5.Oderinu H,Adegbulugbe IC,Shaba OP. Comparision of the dimensional stability of alginate impression disinfected with 1%Hcol using spray or immersion method .J Oral Rehabil.2007;Apr-jun17(2):69-73.
- 6.Cohen BL,Pagnillo M.Dimensional accuracy of three different alginate impression material. J prosthet Dent .1995;4:195-199.
- 7.Zerbert G,Odoman P.Impression materials for complete and partial denture.J Prosthet Dent.1998;34:21-24.
- 8.Featherstone JD. Prevention and reversal of dental caries and role of low level fluoride. Community Dental Oral Epidemiology. 1999;27:31-40.
- 9.ANSI/ADA:Ameorican National Standers Institute / American dental association specification No.18 for hydrocolloid impression. Chicago: Councilon dental material and device.1992
- 10.ISO: International standard organization specification. No 1563 2nd ed.1999.
- 11.Carmichael J.Dispensing and weighting apparatus alginate impression material. J Dent.1984;12(4):348-52.

12. Shambhu HS, Gujjarri A K. A study on the effect on detail reproduction of alginate impression material disinfected with sodium hypochlorite and ultraviolet light. *Inter Dent J* 2005;10(4):41-47.
13. Peter L. Role of chlorhexidine in the management of dental caries. 2008; *Int . Dent.J.*41:279-86.