

Evaluation of Tear Strength of Two Types of Iralgin and its Comparison with Similar Alginate Impression Material

Amir Fayaz¹ Abolghasem Noori^{*1}

¹Dept. of Prosthodontics, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

Abstract

Objectives: Among the various impression materials, for alginate tear strength is probably more important than the compressive strength. The tear strength is important when an impression involves a mechanical undercut and/or lacks bulk strength to resist tearing. This study evaluated tear strength of Iralgin and compared it with tear strength of Alginoplast.

Methods: In this *invitro* experimental study A mold was made with 100mm×20mm×1mm dimensions and a longitudinal prominence in 0.3 mm depth. Twenty-seven specimens (9 Super Iralgin, 9 Pocket Iralgin, and 9 Alginoplast) were selected non-randomizedly. Each specimen prepared corresponding to manufacturer and injected into the mold. And the mold was placed under press. After removing the mold from press, every specimen formed as a trouser-shaped specimen. The specimen was pulled in tensile machine with 50 mm/min speed. The data of specimens in different groups were statistically analyzed using one-way ANOVA, Kolmogorov-Smirnov, and Levene's tests.

Results: Mean of tear strength in first specimen (Super Iralgin), second specimen (Pocket Iralgin), and third specimen (Alginoplast) were 640±38 grf/cm², 500 ±20grf/cm², and 1100±27 grf/cm² respectively. According to ANOVA test, the mean of tear strength was not equal in three specimens ($p<0.01$). According to LSD Multiple Comparison, the first and second specimens were same in tear strength, whereas the third specimen was different from the two former ($p<0.05$ and $p<0.01$).

Conclusion: Super Iralgin and pocket Iralgin were the same in tear strength. Alginoplast was significantly higher than super and pocket Iralgin in tear strength.

Key words: Dental, Impressions, Materials, Standards; Tensile strength

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Corresponding Author:
Noori A.
Email: nooripros@sbmu.ac.ir

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Introduction

Alginate impression material, which is inexpensive and easy to handle, is frequently used in dentistry (1). The chief active ingredient in the alginate impression materials is one of the soluble alginates, such as sodium, potassium, or triethanolamine alginate (2). This ingredient is hydrogel former (3). The setting of alginate hydrocolloid is a process of cross-

linking alginic acids with calcium ions. The alginic acid, which is extracted from certain brown seaweed, is a linear copolymer of β -D-mannuronic acid and α -L-guluronic acid. Mannuronic and guluronic acids are epimers. It is known that the block structure within the alginic acid can vary significantly. Alginates with higher guluronic acid levels normally show a stronger interaction with calcium, and hence, yield greater gel strength. For impression-

making purposes, the alginate is richer in mannuronic acid (2). The amount of force needed to tear a specified test specimen divided by the thickness of the specimen is called the tear strength (2). It is very important that alginate has enough strength in order to do not tear upon removal from mouth. Factors that contribute in alginate gel strength are: 1. P/W ratio, 2. mixing time, 3. time of removal from mouth, and 4. rate of removal from mouth. Clinically, the initial set of alginate is determined by a loss of surface tackiness. An alginate impression should be left in the mouth for an additional 2 to 3 minutes after this initial set to permit the development of additional strength. Early removal of an alginate impression may lead to unnecessary tearing of the impression material. It is important to note that the gel strength doubles during the first 4 minutes after initial gelation. The physical strength of alginate gel is such that a sudden force is more successfully resisted than a slow, sustained force. The material also displays improved elastic recovery when an impression is rapidly removed. Therefore, alginate impressions should be removed from the mouth with a rapid, sustained tug (4).

Cook *et al.* (5) carried out a study with the purpose of measuring ultimate properties of elastomeric impression materials as a function of their age after mixing. Sneed *et al.* (6) compared tear strengths of ten elastomeric impression materials. A modified technique to determine the tear energy of impression materials was established by Vrijhoef *et al.* (7). Webber *et al.* (8) concluded that a modification of Greensmith's trousers method for

determining tear energy can be conveniently applied to extensible materials of dental interest. For alginates, tear strengths vary from 0.4 to 0.7 kN/m, and this property is probably more important than the compressive strength (9). The tear strength is important when an impression involves a mechanical undercut and/or lacks bulk strength to resist tearing (10).

The purpose of this study was to determine the tear strength for Iralgin (alginate impression material) and its comparison with similar overseas type.

Methods

The study was an *invitro* experimental research type. At first an ingot constructed from steel (165mm×58mm×17mm). Then a mold embedded into it (100×20×1mm) with a longitudinal elevation in 0.3 mm height as tear guide (Figure 1). Twenty seven specimens of The specimens were moulded as thin strips 1 mm thick, 20 mm wide and 100 mm long with a lengthwise groove 0.3 mm deep as a crack guide. The materials used in this study were: Super Iralgin and Pocket Iralgin (both from Golchai company, Karaj, Iran) and Alginoplast (Heraeus Kulzer company, Hanau, Germany), each consisted of 9 specimens. The numbers of specimens were derived from other similar studies (they performed on 7 specimens). After mixing each specimen according to manufacturer instruction (5.75 gr powder poured into 12.5 cc distilled water), the material injected into the mold and pressed. For preventing of sticking of the alginate to the mold at the time of removal, a cellophane tape used as a separator. Mixing

time and working time were 30 seconds and 60 seconds respectively. After 3 minutes when alginate specimen set and removed from press, 5 cm of specimen cut at longitudinal notch and trouser-shaped specimen provided for testing in tensometer machine (Monsanto Tensometer, St. Louis, MO, USA). 27 specimens tested in the machine. The trouser-shaped parts of each specimen attached to the machine clamps and tension carried out in 50 mm/min rate (Figure 2) and stress/elongation graph recorded (Figure 3). The data of specimens in different groups were statistically analyzed using one-way ANOVA.

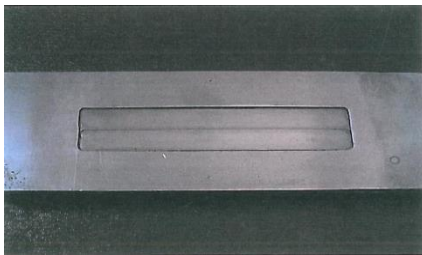


Figure 1- The mould

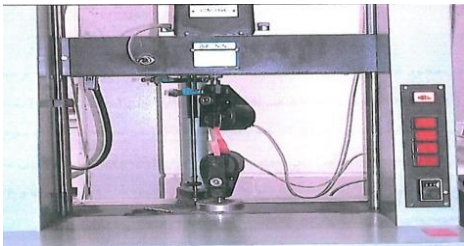


Figure 2- Tensometer

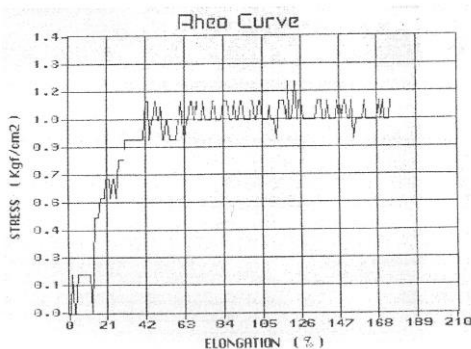


Figure 3-Stress/elongation graph

Results

For every specimen a stress/elongation graph recorded in computer. In vertical axis, two points was distinct: break point and peak point. Break point, major part of plateau of curve, is representative of tear strength. Peak point is representative of maximum tear strength (Figure 3).

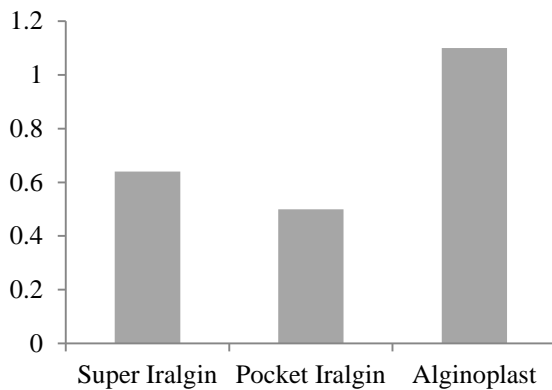
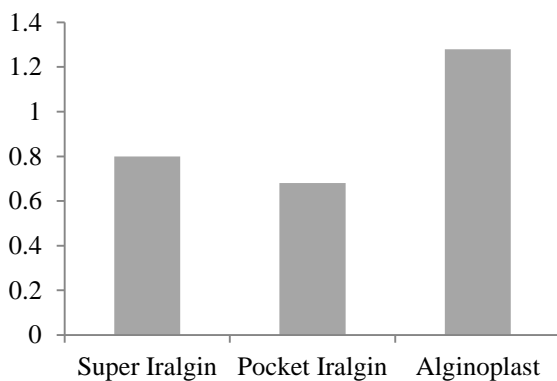
For using ANOVA in this study, two preconditions of this test id est data normality and equality of variances evaluated. For both break point and peak point variables, presumption of data normality by using Kolmogorov-Smirnov test and presumption of equality of variances by using Levene's test were accepted. Table 1 presents comparison of tear strength in three materials and table 2 presents comparison of peak point of tear strength. ANOVA used for tear strength comparison in three materials. According to results of this test, mean of tear strength in three materials was not the same ($p < 0.01$). Super Iralgin and Pocket Iralgin were identical in terms of tear strength, whereas Alginoplast was different from two others ($p < 0.05$ and $p < 0.01$ respectively). ANOVA used for comparison of mean of peak point tear strength in three groups. The results were not the same ($p < 0.01$). Multiple comparisons revealed that Super Iralgin and Pocket Iralgin were the same in terms of peak point tear strength, whereas both were different from Alginoplast ($p < 0.05$ and $p < 0.01$ respectively). The mean of tear strength in three materials is depicted in chart 1 and for peak point tear strength in chart 2.

Table 1- comparison of tear strength in three materials (kgf/cm²)

Statistical indices	Count	Mean	Standard deviation	Confidence interval 95% for mean		Minimum	maximum
				Lower bound	Upper bound		
Super Iralgin	5	0.64	0.38	0.16	1.12	0.20	1.10
Pocket Iralgin	6	0.50	0.20	0.29	0.71	0.30	0.80
Alginoplast	6	1.10	0.27	0.82	1.38	0.70	1.40

Table 2- comparison of peak point of tear strength

Statistical indices	Count	Mean	Standard deviation	Confidence interval 95% for mean		Minimum	maximum
				Lower bound	Upper bound		
Super Iralgin	5	0.80	0.31	0.42	1.18	0.40	1.10
Pocket Iralgin	6	0.68	0.21	0.46	0.91	0.40	1.00
Alginoplast	6	1.28	0.34	0.93	1.64	0.80	1.80

**Chart 1- mean of tear strength in the three materials****Chart 2- mean of pick point tear strength in the three materials**

Discussion

One of the important variables about alginate tear strength is the powder/water ratio. Modifications of correct powder/liquid ratios and proper mixing technique can result in changes in the properties of the gel, tear strength, and elasticity (11). In the Cohen et al study (10), Tare-Free alginate had more significant tear strength (514.5 gr/cm) than three other materials (Kromopan 323.9 gr/cm, Identic 289.9 gr/cm, and Jeltrate 259 gr/cm). Indeed, in that research, there was different between powder/water ratio of diverse alginates. The powder/water ratio in Tare-Free alginate was 1/0.75 and in others was 1/1. In our study, this ratio is identical in three materials and is according to manufacturer instruction (23 gr powder/50 cc water).

Our study agrees with that found for the tear energies of the elastomeric impression materials studied by W.D. Cook *et al* (5) and

the tear data of Sneed *et al* (6) in that the tear energy is quite sensitive to tearing rate. In all three studies the specimen was mounted between grips in a tensile testing machine and was torn at 50 mm/min.

There is no standard method for testing the tear strength of impression materials, since ISO 4823 (Dentistry-Elastomeric impression materials) does not address such a test method (2). Unfortunately, specification no. 18 of ANSI/ADA did not determine a specific amount for tear strength of alginate. However, For alginates, tear strengths vary from 0.4 to 0.7 kN/m, and this property is probably more important than the compressive strength (9). In our study, the amounts were according to gf/cm². On the other hand, there is no standard amount for alginate tear strength. But it is apparent that tear strength of Alginoplast is approximately twice than two other materials.

During inquiry for difference reasons in tear strength for Iralgin and Alginoplast, since the effect of all interfering variables had been omitted by procedure unification, the remaining variable was the used alginate as independent variable. Two ingredients of alginate powder in relation to strength are alginic acid and diatomaceous earth. Alginic acid, which is prepared from a marine plant, is a high molecular weight block copolymer of anhydro- β -D-mannuronic acid and anhydro- α -L-guluronic acid. The properties of alginate raw material depend largely on the degree of polymerization and the ratio of guluronan and mannuronan blocks in the polymeric molecules. The mannuronan regions are stretched and flat, whereas the guluronan regions contribute less flexibility. Also, mainly guluronan blocks bind with

Ca²⁺. Therefore, alginates rich in guluronan form strong, brittle gels, whereas those rich in mannuronan form weaker and more elastic gels (9). Therefore the type of alginic acid applied in Alginoplast and Iralgin may contribute in this difference. Therefore, the problem of Iralgin can be related to this ingredient.

Another ingredient of alginate powder is diatomaceous earth or silicate which constitutes more than half of the ingredients. Diatomaceous earth or fine siliceous particles are used as fillers and control the consistency of the mixed alginate and the flexibility of the set impression. The diatomaceous earth acts as a filler to increase the strength and stiffness of the alginate gel. It also produces a smooth texture and ensures the formation of a firm gel surface that is not tacky (2). Since this ingredient constitutes more than half of the ingredients, it can play an important role in alginate tear strength.

The limitation of our study was inaccessibility to Iralgin ingredients. Whilst appreciating the Golchai company it is recommended that tear strength is improved in later studies by modifying Iralgin ingredients.

Conclusion

Although tear strength of Super Iralgin is slightly more than Pocket Iralgin, there is no significant difference between them statistically. Alginoplast tear strength is significantly more than Super Iralgin ($p < 0.05$) and Pocket Iralgin ($p < 0.01$).

Conflict of Interest: “None Declared”

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