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# The Effects of Natural Disinfectant Solutions on Dimensional Stability of Silicon Impression Material.

Mohammed T. Al-Khafagy

Head of Department of Prosthodontic; College of Dentistry; University of Kufa.

**Abstract**

***Introduction***

It is important to disinfect impression to prevent infection. Accuracy is directly proportion to adaptation of the future prosthesis to the oral mucosa. Most of chemical disinfectant solutions are irritant and, therefore inhalation of disinfectant vapor may present risks to the dental team.

***Materials and methods***

Thirty six high viscosity putty polysiloxane impression were obtained from special designed master model. The impression were grouped according to natural disinfectant solution into lemon juice and apple vinegar solution and then subgroup according to immersion time into 5, 10, 15 min immersion. All impressions were poured with type 4 dental stone then nine measurements were obtained from each cast.

***Results***

All casts obtained from high viscosity putty polysiloxane impressions which immersed in lemon juice were discarded due to bad surface texture and brittle casts. Statistical analysis reveals no significant differences between master model and casts obtained from pouring high viscosity putty polysiloxane impressions after 5 min with and without immersion in apple vinegar solution while, for 10 min group shows significant differences in 5 measurements and no significant differences in 4 measurement. The 15 min group shows highly significant differences between groups regarding all tested measurements.

Percentages of changes of all casts were increased with time of pouring the high viscosity putty polysiloxane impressions either with or without immersion in apple vinegar solution.

***Discussion***

Minimizing the risk of disease transmission in the dental workplace has today become a high priority for the dental profession. Dimensional stability of the impression materials used in prosthetics presents an important factor for the accuracy of dental devices.

Generally, the high viscosity putty polysiloxane impressions shows dimensional changes which inceased with time of pouring. However, there were no significant differences between casts without immersion and casts immersed in apple vinegar solution for 5, 10, 15 min.

***Conclusion***

High viscosity putty polysiloxane impressions can be disinfected effectively for uses of primary impression for completely or partially edentulous arches, as well as producing opposing casts in prosthodontics treatment, making interocclusal devices, and surgical guides.

***Key words:***disinfection, polysiloxane impressions, apple vinegar

## Introduction

Dental impressionsare very important, because they expose the clinical situation to laboratory personnel, allowing the fabrication of accurate and representative casts. Accuracy is directly proportional to the adaptation of the future prosthesis to the oral mucosa, which in turn reflects the success of such prosthesis.

During the process of dental treatment, it is important to disinfect impressions as well as equipment to prevent infection.[1, 2] Numerous contagious diseases such as AIDS, hepatitis, herpes simplex I and II, and tuberculosis can be prevented by simple and practicable infection control measures in dental offices and laboratories.[3, 4]

The American Dental Association (ADA) has issued guidelines regarding impression disinfection that stipulate which disinfectants should be used for different impression materials and also specify the dilution, time, and temperature needed for each agent's optimal performance [5, 6]because it has been observed that materials differ widely in terms of the properties of microbial absorption and retention. [7] The guidelines recommend using an ADA-accepted spray or immersion technique with an approved disinfectant. [5, 6]

However, a recent review concluded that disinfection by immersion is preferred because sprayed disinfectant tends to pool and therefore the entire impression surface may not be adequately covered. This is especially true for hydrophilic and porous materials. [5, 7, 8]

On the other hand, it is critical to weigh the effectiveness of the disinfection procedure against possible negative side effects on the material. [9]

Most of the disinfectants used for spray and immersion techniques are irritants and, therefore, inhalation of the disinfectant vapors may present health risks to the dental team; and toxic disinfectants may also result in the corrosion of metal trays or abnormal dislodgement of the impression from the tray. [10, 11]

Studies indicate that 1.2 g/L chlorhexidine is cytotoxic to human fibroblasts in vitro and is able to induce primary DAN damage in leukocytes and oral mucosal cells.[12]

Lemon juice is a natural disinfectant and antiseptic, prior to the development of modern antiseptics, it was used in hospital for this purpose. The juice can be applied directly to the skin, it is an astringent and a bactericide and it is a useful ingredient in home.

Apple vinegar can also use as a disinfectant in dental field, Spano et al.(2009) reported that the apple vinegar is the effective solution for removal of smear layer when used as root canal chelators. [13]

Estrela et al [14] were found that vinegar had an antimicrobial effect against staphylococcus aureus when used in a ultrasonic cleaning system.

Our previous studies revealed that immersion of silicon impression in lemon juice for 20 min and apple vinegar for 5 min were effectively disinfect the silicon impressions against streptococcus and staphylococcus bacteria.2

Regarding the effect of natural disinfecting solutions on the wettability of silicon impression materials, it have been found that immersion disinfection of silicone impression materials in natural apple vinegar is recommended in preference to maintain wettability of silicone rubber impression materials for short disinfection time as well as improve the wettability when used the apple vinegar with Oromamax light. While the natural lemon juice solution may adversely affect the wettability, especially when used for 10, 15 min immersion to disinfect the putty silicon impression material. [15]

Several studies have concluded that there is no adverse effect of various disinfecting media on the different impression materials, [16, 17, 18] but other studies have indicated adverse effects of disinfectants on the dimensional stability of some impression materials. [19, 20]

However, there have been no investigations on the effect of natural disinfectants on the dimensional stability of polysiloxane impression materials. It has been hypothesized that disinfection procedures will not significantly affect dimensional stability of the resultant stone casts. The objective of this study was to evaluate the dimensional stability of stone casts made from polysiloxane impression materials when these are immersed in natural disinfectant solutions for different immersion time.

**Materials and Methods**

For the dimensional stability test, specimens were obtained from impressions of hot-cure acrylic master model that represented dental arch. Reference points for the measurements consisted of three cones, one of them located in the anterior region and two other symmetrical points in the left and right posterior regions.The master model was specially designed from modeling wax and converted to hot-cure acrylic by traditional flasking technique (figure 1) Special acrylic resin trays were fabricated on the artificial stone cast of the master model which provided a uniform 2-mm thickness of the impression material. To make special tray, 2 sheets of softened base-plate wax were adapted on the artificial stone cast to a thickness of approximately 2.5 mm and was then trimmed. The light cure sheet was adapted on the duplicate stone cast and was then trimmed. Photopolymerization of the materials was achieved with a Triad visible light curing unit (Vertex-Dental Netherland). The polymerized tray was trimmed, and the master model was tested for the tray to ensure a consistent surrounding space.

The materials used in this study are those that are commonly used in clinics and laboratories in our environment. These included master model hot-cure acrylic (Vertex-Dental Netherland), light-cure plastic special tray (TruTray, Vertex-Dental Netherland), very high viscosity polysiloxane condensation silicon impression material (Zetaplus, Zhermack clinical, Italy), dental stone type 4 (Elite Stone, Zhermack technical, Italy), electronic vernier caliper (Meter 8. Com, China). Natural disinfectant solutions include commercially available apple vinegar and lemon juice solution (Zer. Com, Turkey).

Polysiloxane impressions of the master model were made according to manufacturer's instructions and lifted on the master model for an extra minute before separation. The impressions were fabricated by one operator in a manner that closely approximated steps used in the clinical setting. Extreme care was taken to apply the same amount of material into the special tray for each sample. The same seating pattern of the master model was used for every impression, to achieve a consistent thickness of material.

In order to exclude the effect of time before pouring the impression, the tested samples were grouped as follow:

**I/ Lemon juice groups:**

***A/ Five minutes groups:***

1-Control group: three polysiloxane impressions were rinsed under tap water for one minute and air dried and kept for 5 min in well-sealed nylon pack before pouring.

2-Experimental groups: three polysiloxane impressions were rinsed under tap water for one minute, air dried and then immersed in lemon juice for 5 minutes and then washed with distill water before pouring.

***B/ Ten minutes groups:***

1-Control group: three polysiloxane impressions were rinsed under tap water for one minute and air dried and kept for 10 min in well-sealed nylon pack before pouring.

2-Experimental groups: three polysiloxane impressions were rinsed under tap water for one minute, air dried and then immersed in lemon juice for 10 minutes and then washed with distill water before pouring.

***C/ Fifteen minutes groups:***

1-Control group: three polysiloxane impressions were rinsed under tap water for one minute and air dried and kept for 15 min in well-sealed nylon pack before pouring.

2-Experimental groups: three polysiloxane impressions were rinsed under tap water for one minute, air dried and then immersed in lemon juice for 15 minutes and then washed with distill water before pouring.

 

**II/ Apple vinegar groups:**

***A/ Five minutes groups:***

1-Control group: three polysiloxane impressions were rinsed under tap water for one minute and air dried and kept for 5 min in well-sealed nylon pack before pouring.

2-Experimental groups: three polysiloxane impressions were rinsed under tap water for one minute, air dried and then immersed in apple vinegar for 5 minutes and then washed with distill water before pouring.

***B/ Ten minutes groups:***

1-Control group: three polysiloxane impressions were rinsed under tap water for one minute and air dried and kept for 10 min in well-sealed nylon pack before pouring.

2-Experimental groups: three polysiloxane impressions were rinsed under tap water for one minute, air dried and then immersed in apple vinegar for 10 minutes and then washed with distill water before pouring.

***C/ Fifteen minutes groups:***

1-Control group: three polysiloxane impressions were rinsed under tap water for one minute and air dried and kept for 15 min in well-sealed nylon pack before pouring.

2-Experimental groups: three polysiloxane impressions were rinsed under tap water for one minute, air dried and then immersed in apple vinegar for 15 minutes and then washed with distill water before pouring.

For all 36 impressions, the vacuum-mixed dental stone, obtained from one batch prepared with the recommended ratio of powder to water, was poured into the impressions in a standardized manner. The poured casts were left to set for 1 hour. After being removed from the impressions, casts were allowed to dry for 24 hours before measurements were obtained.

Totally nine different measurements were made in all three dimensions on master and stone models. The measurements were coded in to AB, AC, BC, which represents the distances between the tips of the three cones, and LA, LB, LC, which represents the length of the three cones, and DA, DB, DC, which represents the diameter of the base of the three cones. (Figure 2)

The dimensions of each sample of the master model and the 36 stone casts were measured by a single investigator using electronic vernier caliper. To eliminate any unintentional bias in the measurement process, the casts were coded, and the key coding was kept by a person not involved in performing the measurements.

The percent dimensional change (Δd) was calculated as follows:

$$\Delta d = \frac{\text{Cast measurement - Control measurement (master model)}}{\text{Control measurement (master model)}} \times 100$$

**Statistical Analysis**

All the collected data were subjected to computerized statistical analyses with SPSS statistical software for windows (version 22, SPSS Inc Chicago, IL) computer program. The statistical analysis included: **1) Descriptive Statistic** (Mean and Standard deviation). **2) Inferential Statistic** (ANOVA test, LSD test). All hypotheses were tested at p=0.05.

**Results**

**General findings**

For the all impression disinfected with lemon juice regarding all immersion times (5 min,10 min, and 15 min) were discarded due to bad surface texture and brittle resulted cast.

The key cod of master model and tested groups shows in table (1).

Mean and standard deviation of the nine measurements of master model (control) and stone casts resultant from pouring the polysiloxane impression as well as stone casts resultant from pouring the polysiloxaneimpression after immersed in apple vinegar for 5, 10, and 15 min shows in (Table 2, figure 3). The stander deviation of master model was (0) because the numbers of measurements were repeated three times for statistical purpose.

One-way ANOVA test of 5 min groups reveals no significant differences between groups regarding all tested measurements except the length of cone (A) and (B). Table (3)

Multiple comparisons LSD test between master model and stone casts created after pouring polysiloxane impression after 5 min and stone casts created after immersion of polysiloxane impression for 5 min shows in table (4). LSD test reveals no significant differences except in length of cone (A) and (B).

One-way ANOVA test of 10 min groups shows significant differences between groups regarding all tested measurements except the length of (AC), (CB), (LC), and (DA) measurements. Table (5)

Multiple comparisons LSD test between master model and stone casts created after pouring polysiloxane impression after 10 min and stone casts created after immersion of polysiloxane impression for 10 min reveals highly significant differences between master model and stone casts poured after 10 min without immersion, while there were no significant differences between stone casts poured after 10 min without immersion and immersion in apple vinegar for 10 min except there were significant differences in measurements (LA), (DB) and (DC) measurements. Table (6)

ANOVA test of 15 min groups shows highly significant differences between groups regarding all tested measurements. Table (7)

Multiple comparisons LSD test between master model and stone casts created after pouring polysiloxane impression after 15 min and stone casts created after immersion of polysiloxane impression for 15 min reveals highly significant differences between master model and stone casts poured after 15 min without immersion, as well as master model and stone casts created after immersion of ploysiloxane impression in apple vinegar for 15 min, while there were no significant differences between stone casts poured after 15 min without immersion and immersion in apple vinegar for 15 min regarding all tested measurements. Table (8)
Mean percentage of changes of tested stone casts regarding all groups shows that 15 min group were higher percentage of changes than 5 and 10 min groups. Table (9) Figure (4)

**Discussion**

Minimizing the risk of disease transmission in the dental workplace has today become a high priority for the dental profession. Contaminated materials are routinely sent to dental laboratories thus creating an occupational hazard. Microbial contamination of dental materials and prosthesis has been documented by the work of Wakefeld. [21] Such pathogenic contaminants include bacteria such as *E.coli*, *Staphylococcus aureus, Streptococcus mutans,* Yeast and Candida albicans.[22]

Dimensional stability of the impression materials used in prosthetics presents an important factor for the accuracy of dental devices. Dental impression is the first phase of the complicated sequel of dental device manufacture. Each phase contributes to the overall error of the future work and can lead to poor quality and diminished accuracy. An error made in the early stages of production cannot be corrected in further process, but becomes the source of the new errors. That is why the knowledge of impression materials properties is imperative for dental practice, so that a therapist can choose appropriate mass that corresponds to the present situation.

The majority of this dimensional shrinkage of polysiloxane is due to continued polymerization occurring within the first three minutes of removal of the impression from the mouth.[23]

Anusavice[24] stated that there are five main reasons to promote dimensional changes in elastomeric materials: polymerization shrinkage, by-product release during condensation reactions, thermal shrinkage due to temperature changes, sorption after exposure to water, disinfectants, or high humidity environments for long periods, and incomplete elastic deformation recovery due to viscoelastic behaviour.

The change in linear dimensions may not be due to change from impression material but rather from factors associated with setting expansion of the dental stone. Under ordinary conditions, low to moderate –strength dental stone have setting expansion of about 0.15% to 0.25%. Typically, over 75% of the setting expansion observed at 24 hours occurs during the first hour of setting. [25]

Results of this study reveals that the lemon juice was contraindicated as disinfection solution due to bad surface texture and brittle stone cast while, all casts obtained from pouring very high viscosity polysiloxane impression after immersion in apple vinegar solution for 5, 10 and 15 min were have a good surface texture and strength cast like casts obtained from pouring impression without immersion.

Apple vinegar group for 5 min immersion generally, reveals no significant differences between master model and stone cast with and without immersion, while for 10 min group there were significant differences between groups but there were no significant differences between stone casts poured after 10 min with and without immersion in apple vinegar solution.

Same significant differences were observed in 15 min groups and still there were no significant differences between stone casts poured from very high viscosity polysiloxane impression with and without immersion in apple vinegar solution.

Change percentage results revealed that as time of pouring the impression increases, the change percentage increase regarding with or without immersion in apple vinegar solution.

 

In general over size casts may be related polymerization shrinkage of very high viscosity polysiloxane impression which increases with time, this agrees with Chee and Donovan,[23] and may be related to setting expansion of the dental stone.[25]

**Conclusion**

Within the limits of this study it can be concluded that immersion of very high viscosity polysiloxane in lemon juice is not recommended due to bad surface texture and brittle cast, while immersion in apple vinegar solution was not affect such a properties.

Dimensional changes of very high viscosity polysiloxane impression were increased with time either with or without immersion in apple vinegar solution

**Clinical significant**

The very high viscosity polysiloxane impression can be disinfected with apple vinegar solution for purpose of primary impression for completely or partially edentulous arches, as well as producing opposing casts in prosthodontics treatment, making interocclusal devices, and surgical guides.

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**Notes:**

Fig 1: Master model

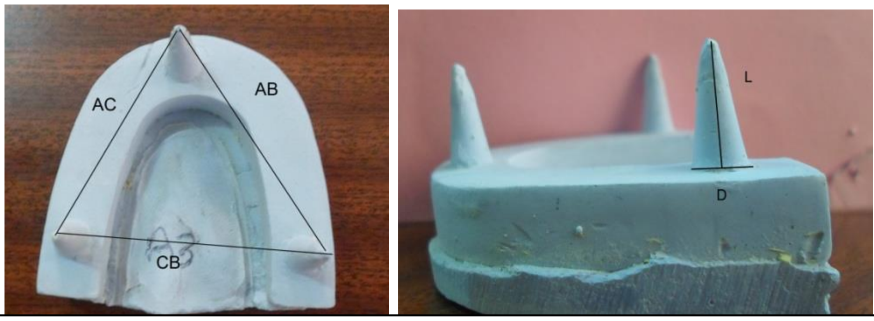


Figure 2: The tested measurements of stone cast in which measurements (AB), (AC), and (CB) represents the distance between the tips of the cons and (L) represent the length of the cone and (D) represent the measurement of the base of the cone.

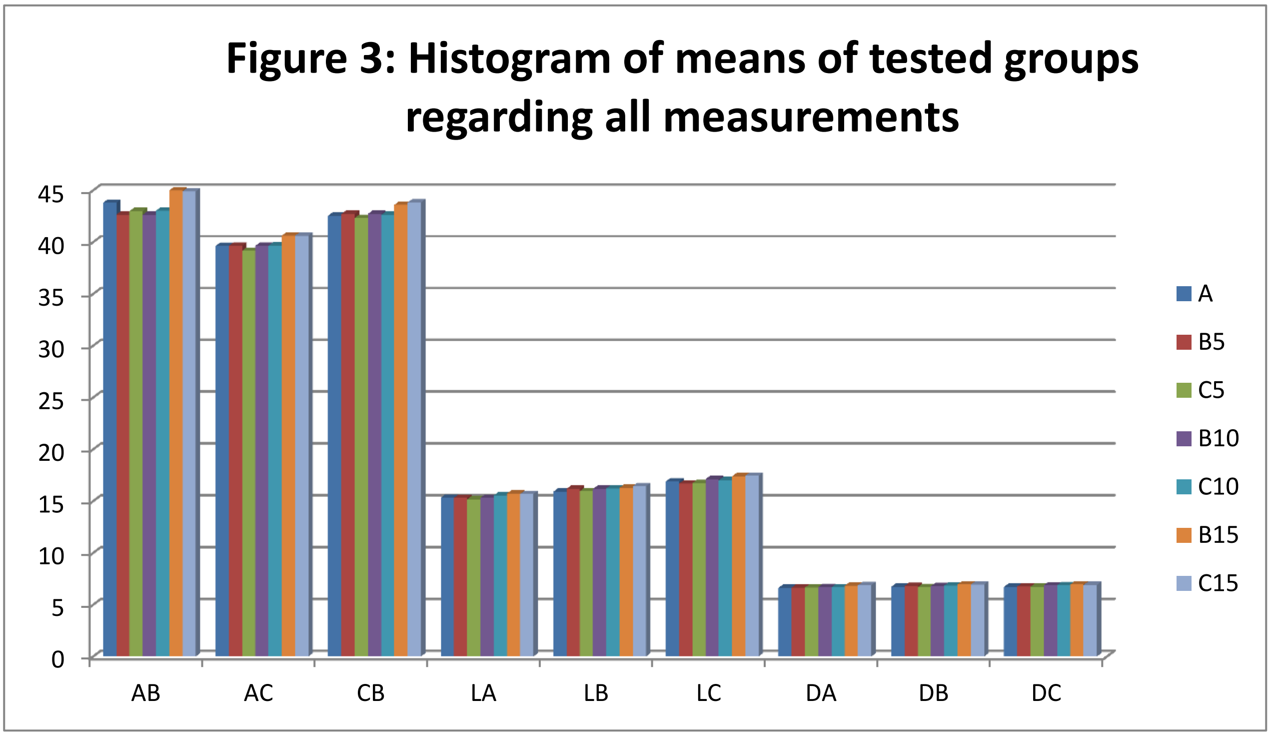
Figure 3: Histogram of means of tested groups regarding all measurements
45
40
35
30
25
20
15
10
5
0
AB
AC
CB
LA
LB
LC
DA
DB
DC
A
B5
C5
B10
C10
B15
C15

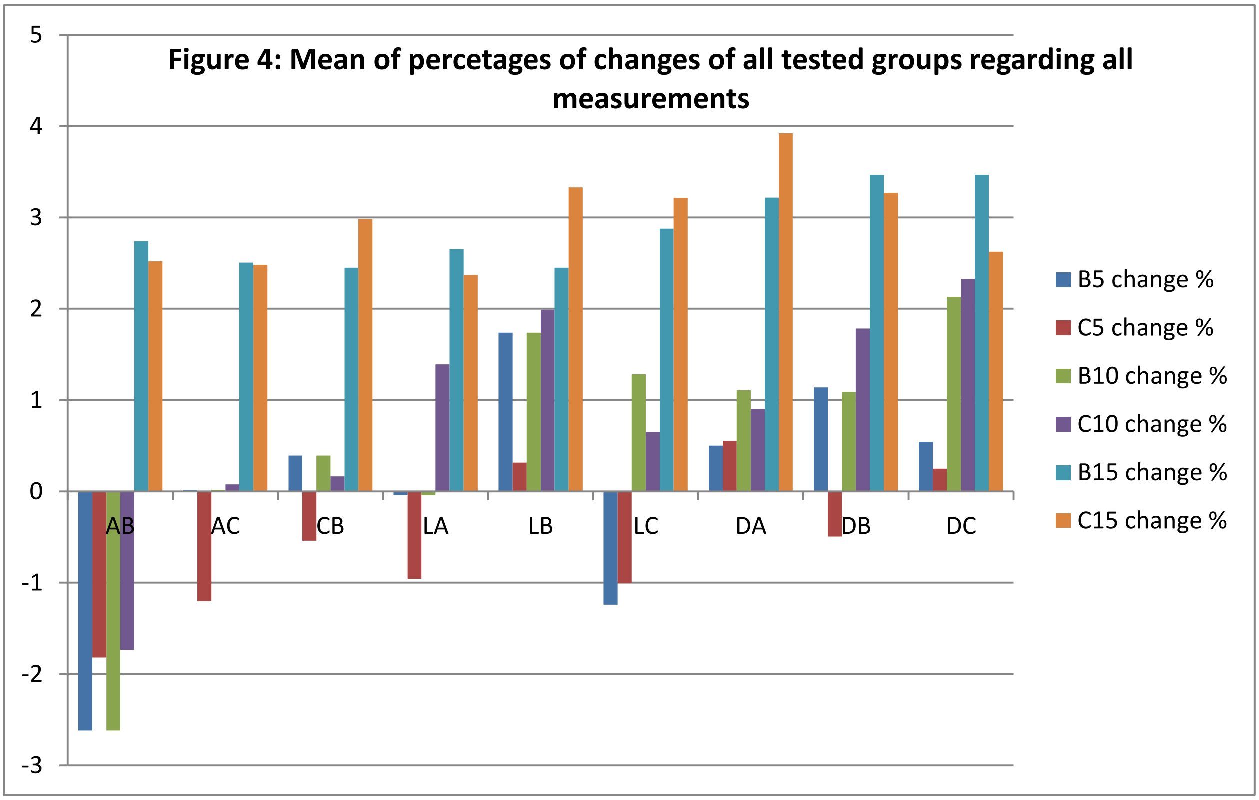
Figure 4: Mean of percetages of changes of all tested groups regarding all measurements
5
4
3
2
1
0
-1
-2
-3
AB
AC
CB
LA
LB
LC
DA
DB
DC
B5 change %
C5 change %
B10 change %
C10 change %
B15 change %
C15 change %

 

**Table 1: The cods of master model and stone casts regarding apple vinegar groups.**

| Groups | Cod |
|---|---|
| Master model | A |
| Stone cast poured after 5 min (without immersion) | B5 |
| Stone cast poured after immersion in apple vinegar for 5 min | C5 |
| Stone cast poured after 10 min (without immersion) | B10 |
| Stone cast poured after immersion in apple vinegar for 10 min | C10 |
| Stone cast poured after 15 min (without immersion) | B15 |
| Stone cast poured after immersion in apple vinegar for 15 min | C15 |

**Table 2: Mean and standard deviation of the tested dimensions of stone casts regarding the control and experimental groups in mm**

| Measurements | A | | B5 | | C5 | | B10 | | C10 | | B15 | | C15 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| AB | 43.8 | 0 | 42.65333333 | 0.03511885 | 43.00333 | 0.231805 | 42.65333 | 0.035119 | 43.04 | 0.292062 | 45 | 0.1 | 44.90333 | 0.095044 |
| AC | 39.64 | 0 | 39.64666667 | 0.04618802 | 39.16333 | 0.209841 | 39.64667 | 0.046188 | 39.67 | 0.242693 | 40.63333 | 0.135769 | 40.62333 | 0.063509 |
| CB | 42.56 | 0 | 42.72666667 | 0.0305505 | 42.33 | 0.204206 | 42.72667 | 0.030551 | 42.63 | 0.28688 | 43.60333 | 0.185023 | 43.83 | 0.14 |
| LA | 15.33 | 0 | 15.32333333 | 0.04041452 | 15.18333 | 0.070238 | 15.32333 | 0.040415 | 15.54333 | 0.011547 | 15.73667 | 0.047258 | 15.69333 | 0.057735 |
| LB | 15.91 | 0 | 16.18666667 | 0.0057735 | 15.96 | 0.026458 | 16.18667 | 0.005774 | 16.22667 | 0.030551 | 16.3 | 0.086603 | 16.44 | 0.017321 |
| LC | 16.91 | 0 | 16.7 | 0.12124356 | 16.74 | 0.01 | 17.12667 | 0.020817 | 17.02 | 0.079373 | 17.39667 | 0.141539 | 17.45333 | 0.055076 |
| DA | 6.63 | 0 | 6.663333333 | 0.01154701 | 6.666667 | 0.066583 | 6.703333 | 0.005774 | 6.69 | 0.036056 | 6.843333 | 0.064291 | 6.89 | 0.026458 |
| DB | 6.73 | 0 | 6.806666667 | 0.0057735 | 6.696667 | 0.072342 | 6.803333 | 0.015275 | 6.85 | 0.026458 | 6.963333 | 0.011547 | 6.95 | 0.03 |
| DC | 6.73 | 0 | 6.766666667 | 0.01527525 | 6.746667 | 0.049329 | 6.873333 | 0.020817 | 6.886667 | 0.011547 | 6.963333 | 0.011547 | 6.906667 | 0.037859 |

**Table 3: ANOVA test between groups of master model and tested groups regarding 5 min treatment.**

| Measurements | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| **AB** | .039 | 2 | .019 | .410 | .681 |
| **AC** | .238 | 2 | .119 | 8.375 | .018 |
| **CB** | .238 | 2 | .119 | 8.375 | .018 |
| **LA** | .061 | 2 | .031 | 18.079 | .003* |
| **LB** | .130 | 2 | .065 | 266.773 | <.0001* |
| **LC** | .003 | 2 | .001 | 2.048 | .210 |
| **DA** | .002 | 2 | .001 | .810 | .488 |
| **DB** | .019 | 2 | .010 | 5.437 | .045 |
| **DC** | .003 | 2 | .001 | 8.643 | .017 |

**Table 4: LSD test between master model and tested groups regarding 5 min treatment.**

| Measurements | Groups | B5 | C5 |
|---|---|---|---|
| AB | **A** | .440 | .491 |
| | **B5** | | .928 |
| AC | **A** | .138 | .056 |
| | **B5** | | .007 |
| CB | **A** | .138 | .056 |
| | **B5** | | .007 |
| LA | **A** | .214 | .005 |
| | **B5** | | .001* |
| LB | **A** | <.0001* | .008 |
| | **B5** | | <.0001* |
| LC | **A** | .318 | .090 |
| | **B5** | | .387 |
| DA | **A** | .336 | .294 |
| | **B5** | | .920 |
| DB | **A** | .066 | .368 |
| | **B5** | | .018 |
| DC | **A** | .011 | .011 |
| | **B5** | | 1.000 |

**Table 5: ANOVA test between groups of master model and tested groups regarding 10 min treatment.**

| Measurements | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| **AB** | 2.667 | 2 | 1.333 | 210.159 | <.0001* |
| **AC** | .088 | 2 | .044 | 11.655 | .009 |
| **CB** | .139 | 2 | .069 | 11.126 | .010 |
| **LA** | .073 | 2 | .036 | 251.385 | <.0001* |
| **LB** | .178 | 2 | .089 | 276.862 | <.0001* |
| **LC** | .094 | 2 | .047 | 5.709 | .041 |
| **DA** | .011 | 2 | .005 | 7.806 | .021 |
| **DB** | .022 | 2 | .011 | 35.286 | <.0001* |
| **DC** | .031 | 2 | .016 | 26.547 | .001* |

**Table 6: LSD test between master model and tested groups regarding 10 min treatment.**

| Measurements | Groups | B10 | C10 |
|---|---|---|---|
| AB | A | <.0001* | <.0001* |
| | B10 | | .188 |
| AC | A | .011 | .004* |
| | B10 | | .357 |
| CB | A | .007 | .006 |
| | B10 | | .843 |
| LA | A | .001* | <.0001* |
| | B10 | | <.0001* |
| LB | A | <.0001* | <.0001* |
| | B10 | | .034 |
| LC | A | .026* | .026* |
| | B10 | | 1.000 |
| DA | A | .014 | .014 |
| | B10 | | 1.000 |
| DB | A | .002* | <.0001* |
| | B10 | | .018 |
| DC | A | .001* | .001* |
| | B10 | | .872 |

**Table 7: ANOVA test between groups of master model and tested groups regarding 15 min treatment.**

| Measurements | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| **AB** | 2.667 | 2 | 1.333 | 210.159 | <.0001* |
| **AC** | 1.954 | 2 | .977 | 130.444 | <.0001* |
| **CB** | 2.753 | 2 | 1.376 | 76.704 | <.0001* |
| **LA** | .299 | 2 | .150 | 80.641 | <.0001* |
| **LB** | .453 | 2 | .226 | 87.038 | <.0001* |
| **LC** | .535 | 2 | .268 | 34.808 | <.0001* |
| **DA** | .115 | 2 | .058 | 35.779 | <.0001* |
| **DB** | .103 | 2 | .052 | 149.548 | <.0001* |
| **DC** | .099 | 2 | .050 | 66.552 | <.0001* |

**Table 8: LSD test between master model and tested groups regarding 15 min treatment.**

| Measurements | Groups | B15 | C15 |
|---|---|---|---|
| **AB** | A | <.0001* | <.0001* |
| | B15 | | .188 |
| **AC** | A | <.0001* | <.0001* |
| | B15 | | .892 |
| **CB** | A | <.0001* | <.0001* |
| | B15 | | .084 |
| **LA** | A | <.0001* | <.0001* |
| | B15 | | .264 |
| **LB** | A | <.0001* | <.0001* |
| | B15 | | .015 |
| **LC** | A | <.0001* | <.0001* |
| | B15 | | .459 |
| **DA** | A | .001* | <.0001* |
| | B15 | | .204 |
| **DB** | A | <.0001* | <.0001* |
| | B15 | | .413 |
| **DC** | A | <.0001* | <.0001* |
| | B15 | | .335 |

**Table 9: Mean percentage of changes of tested stone casts regarding all groups**

| Measurements | B5 change % | C5 change % | B10 change % | C10 change % | B15 change % | C15 change % |
|---|---|---|---|---|---|---|
| **AB** | -2.61796 | -1.81887 | -2.61796 | -1.73516 | 2.739726 | 2.51902588 |
| **AC** | 0.016818 | -1.20249 | 0.016818 | 0.075681 | 2.505886 | 2.48065927 |
| **CB** | 0.391604 | -0.54041 | 0.391604 | 0.164474 | 2.451441 | 2.98402256 |
| **LA** | -0.04349 | -0.95673 | -0.04349 | 1.391607 | 2.652751 | 2.37008045 |
| **LB** | 1.738948 | 0.314268 | 1.738948 | 1.990362 | 2.451288 | 3.33123821 |
| **LC** | -1.24187 | -1.00532 | 1.281293 | 0.650503 | 2.877981 | 3.2130889 |
| **DA** | 0.502765 | 0.553042 | 1.106083 | 0.904977 | 3.217697 | 3.92156863 |
| **DB** | 1.139178 | -0.49529 | 1.089648 | 1.783061 | 3.467063 | 3.26894502 |
| **DC** | 0.544824 | 0.247647 | 2.129767 | 2.327885 | 3.467063 | 2.62506191 |

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