

## Some Mechanical Properties of Dental Stone Specimens after Disinfections by 70% Hospital Sprit

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### ABSTRACT

**Background and objectives:** The transmission of oral pathogens to impression and subsequently on to gypsum casts had been demonstrated. The aim of the study to investigate the effect of disinfections of type III dental stone casts by spraying and immersion in 70% hospital sprit (ethanol) on the compressive strength and surface roughness at two different time intervals (24 and 48) hours.

**Materials and methods:** Forty eight cylindrical stone specimens (12 for each group), were prepared for compressive strength and surface roughness testing. Six specimens of each group were tested after (24) hours and the other six after (48) hours.

**Results:** The study showed no significant differences in values of compressive strength and surface roughness between the control and sprayed groups at (24 and 48) hours, this could be due to the fact that the sprayed specimens absorbs fewer amounts of disinfectants than the immersed groups.

**Conclusions:** The immersion of the specimens in (70%) ethanol for (10) seconds and (30) minutes decrease the compressive strength and increase the surface roughness.

**Keywords:** Dental stone, disinfections, surface roughness, compressive strength.

### INTRODUCTION:

Gypsum is the dihydrate form of calcium sulfate, which on heating losses part of the water, and converts to calcium sulfate hemihydrates, and when mixed with water the reverse reaction take place<sup>1</sup>. Dental stone (type III) is type of gypsum products, ideal for making full or partial denture models, and orthodontic models. The casts requiring a high compressive strength and less surface roughness, which is the most important mechanical properties<sup>2,3</sup>. Dental personal having patient contact includes dentist, dental students, dental auxiliaries and all dental laboratory personal<sup>4,5</sup>. Prosthetic patients are high risk patients relative to their potential to transmit infectious diseases as well as acquire it. Items that pass from the clinic to the laboratory such as impressions, occlusal rims; dentures are taken straight from the patient's mouth and passed to the dental technician. During

fabrication of a prosthesis contamination of the cast can occurred<sup>6,7</sup>. Therefore one should have an effective means to disinfect the dental cast before its used in the dental office or sent to the dental laboratory because the casts are made from contaminated impressions which can be a medium for cross – contamination between patients and dental personal<sup>8</sup>. The methods of decontamination of the casts include incorporating chemicals into gypsum at the time of mixing or by immersion in or spraying with the disinfectant like hypochlorite, iodophor, phenol or glutaraldehyde solutions<sup>9,10</sup>. The aim of this study is to investigate the effect of disinfections of type III dental stone casts by spraying or immersion in 70% hospital sprit (ethanol) on the compressive strength and surface roughness at two different time intervals (24 and 48 hours).

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## MATERIALS AND METHODS:

Special split mold was made of brass according to ADA specification No (25) in order to prepare (48) cylindrical stone specimens with dimensions of (20 mm) in diameter and (40 mm) length for compressive strength and surface roughness testing. Each 100 gm of dental stone powder measured by electronic balance was mixed with 30 ml of distilled water. The mold was coated with a very thin layer of Vaseline before pouring the mix, the mold retained on a glass plate and the over filled vibrated mold was covered also with another glass plate and pressed firmly in contact with the top surface of the mold. The specimens were removed from the split mold after half an hour from the start of mixing, and the study groups of specimens were disinfected directly. All the specimens then allowed to air dried at room temperature ( $22 \pm 2 \text{ C}^\circ$  and  $45 \pm 8 \%$  relative humidity).

### Compressive testing machine and procedure:

The test for compressive strength was conducted on a digital compressive strength testing machine, which designed that prior to testing, data about the shape and dimensions of the specimen are introduced through the digital screen of the machine, such as shape: Cylindrical, diameter: 20 mm, and height 40 mm. The specimen placed on the testing machine so that the top and the bottom of the specimen in contact with the steel, flat, ridged platens and the specimen was loaded to failure. The maximum load in Kilo Newton carried by the specimen and the compressive strength in  $\text{N/mm}^2$  were registered as shown on the screen of the machine. The compressive strength value in  $\text{Kg/cm}^2$  obtained by multiplies the value by  $100 / 9.8$ .

### Surface roughness test:

The surface used for measuring the roughness was formed by processing against the glass plate under the brass mold. Surface Profilometer was used to measure surface

with a diamond stylus, which travels on the straight line along the surface. The average surface roughness were expressed and calculated as (Ra) value in micrometer. The average surface roughness (Ra) was measured at three locations randomly on the surface of each specimen and the mean of the three readings was obtained and used in this study<sup>11</sup>.

### Grouping of the specimens:

1. Control group: Six specimens tested after (24) hours and six tested after (48) hours bench drying.
2. Sprayed group: The spray container that contain 70% hospitals sprit was hold at fixed height, distance and angle from the stone specimen and each one was sprayed from four aspects until saturated. The stone specimens were then wrapped in a disinfectant moistened paper towel to maintain the concentration of the surface disinfectant for the allowed time (30) minutes. Six sprayed specimens were tested after (24) hours and the other six after (48) hours bench drying.
- Immersion group for (10) seconds: The specimens immersed for (10) seconds in a suitable sized container filled with (500) ml of 70% hospital spirit, then wrapped in a disinfectant moistened paper towel to maintain the concentration of the surface disinfectant for the allowed time of (30) minutes, Six specimens were tested after (24) hours and the other six after (48) hours bench drying.
- Immersion group for (30) minutes: Six specimens tested after (24) hours and six tested after (48) hours bench drying.

## RESULTS:

### Compressive strength test after 24 hours:

The study showed that the immersions specimens for (10) seconds and (30) minutes showed the lowest mean values, while the sprayed and control specimens showed the highest mean values of compressive strength, (Table 1). Statistical analysis by ANOVA test showed a highly significant difference between the test

**Table(1):** Compressive strength values in Kg/cm<sup>2</sup> tested after (24) hours and (48) hours.

Group	After (24) hours.			After (48) hours.		
	Mean value	Maximum value	Minimum value	Mean value	Maximum value	Minimum value
Control	159.44	183.7	124.18	170.8	186.32	132.6
Spray	162.95	185.9	137.55	171.3	190.91	149.1
Immersion 10seconds	143.09	168.8	118.16	124.8	133.77	120.9
Immersion 30 minutes	119.04	125.1	116.26	113.9	119.54	109.6

groups (Table 2). Student – t – test showed that there was no significant difference between the control and the sprayed or immersion specimens for (10) seconds, while a highly significant difference in compressive strength was found between the control and the immersion specimens for (30) minutes.

Similar findings were also obtained for the sprayed and immersed specimens for (30) minutes as shown in (Table 3).

**Table (2):** ANOVA test of compressive strength tested after (24) hours and after (48)

S.O.V	After (24) hours					After (48) hours.				
	S.S	D.F	M.S	F	P. Value	S.S	D.F	M.S	F	P. Value
Be-tween groups	10960.9	3	3653.6	11.2	<0.01 highly significant	20613.5	3	6871.1	34.9	<0.01 highly significant
Within groups	6499.7	20	324.9	-----	-----	3933.7	20	196.6	-----	-----
<b>Total</b>	<b>17460.7</b>	<b>23</b>	-----	-----	-----	<b>24547.2</b>	<b>23</b>	-----	-----	-----

**Table (3):** Student – t – test analysis of compressive strength tested after (24).

Group	After (24) hours.		After (48) hours.	
	P. Value	Significance	P. Value	Significance
Control-Spray	0.763	No significant	0.965	No significant
Control - Immersion 10 seconds	0.218	No significant	0.002	Highly significant
Control - immersion 30 minutes	0.0019	Highly significant	0.0004	Highly significant
Spray - immersion 10 seconds	0.102	No significant	0.0003	Highly significant
Spray - immersion 30 minutes	0.0004	Highly significant	0.00001	Highly significant

**Compressive strength test after 48 hours:**

The sprayed and the control specimens showed the highest mean values than the immersion specimens for (10) seconds or (30) minutes, (Table 1). Statistical analysis by ANOVA test showed a highly significant difference between the test groups, (Table 2). Student t-test showed that there were no significant differences between the control and the sprayed specimens in compressive strength, while the relations between the other specimens are highly significant, (Table 3).

**Surface roughness after 24 hours:**

The study showed that the control and sprayed specimens showed less mean values than the immersions specimens, (Table 4).

Statistical analysis by ANOVA test showed a highly significant difference between the

test groups, (Table 5). Student t-test analysis showed that there were highly significant differences between the control or sprayed specimens with the immersions specimens for (30) minutes, while the relations between the other specimens are with no significance, except the significant relation between the control and immersion groups for (10) seconds, (Table 6).

**Comparison between the results tested after 24 and 48 hours:**

Using t – test analysis between the means of each group specimens tested after (24) hours and the same group specimens tested after (48) hours revealed that there was no significant difference between the mean values regarding compressive strength, and also the surface roughness, except for the immersion specimens for (10) seconds that showed significant difference in surface roughness as shown in (Table 7).

**Table(4): Surface roughness value in  $\mu\text{m}$  tested after (24) and (48) hours.**

Group	After (24) hours.			After (48) hours.		
	Mean value	Maximum value	Minimum value	Mean value	Maximum value	Minimum value
Control	0.596	0.9	0.36	0.695	0.81	0.55
Spray	0.623	0.78	0.49	0.758	1.22	0.54
Immersion	0.705	0.91	0.6	0.863	1.1	0.75
10 seconds						
Immersion	1.19	1.46	0.95	1.23	1.39	0.99
30 minutes						

**Table (5): ANOVA test of surface roughness value tested after (24) and (48) hours.**

S.O.V	After (24) hours.					After (48) hours.				
	S.S	D.F	M.S	F	P. Value	S.S	D.F	M.S	F	P.Value
Between groups	2.0235	4	0.505883	16.44	<0.01 highly significant	138712.9	4	34678.22	349.5	<0.01 highly significant
Within groups	0.769283	25	0.030771	-----	-----	2480.498	25	99.21994	-----	-----
Total	2.792817	29	-----	-----	-----	141193.4	29	-----	-----	-----

**Table (6): Student t-test analysis of surface roughness tested after (24) and (48) hours.**

Groups	After (24) hours		After (48) hours	
	P. Value	Significance	P. Value	Significance
Control - Spray	0.81	No significant	0.572	No significant
Control - Immersion 10 seconds	0.322	No significant	0.031	Significant
Control - immersion 30 minutes	<0.01	Highly significant	<0.01	Highly significant
Spray - immersion 10 seconds	0.3	No significant	0.372	No significant
Spray - immersion 30 minutes	<0.01	Highly significant	<0.01	Highly significant

**Table (7): Student-t test analysis between the means of each group specimens tested after (24) hours and the same group specimens tested after (48) hours .**

Group	Type of test	P. Value	Significance
Control 24 hours-control 48 hours	Surface roughness	0.359	No significant
	Compressive strength	0.399	No significant
Spray 24 hours-spray 48 hours	Surface roughness	0.271	No significant
	Compressive strength	0.406	No significant
Immersion 24 hours-immersion 48 hours (10 seconds)	Surface roughness	0.045	Significant
	Compressive strength	0.077	No significant
Immersion 24 hours-immersion 48 hours (30 minutes)	Surface roughness	0.55	No significant
	Compressive strength	0.216	No significant

**DISCUSSION:**

Casts poured from impressions can harbor infectious microorganisms that can be distributed throughout the laboratory when the casts are trimmed<sup>12,13</sup>. The American Council on Dental Therapeutic Services and Dental Laboratory Relations (1985), stated that models can be disinfected with a spray of Iodophor, phenol and glutaraldehyde according to the manufacture's instruction without weakens the compressive

strength. Previous studies also used sodium hypochlorite solution as disinfectants according to ADA recommendations. Abdulla (2006) found a decrease in compressive strength of dental stone casts after spraying or immersion in 0.5% sodium hypochlorite disinfectant<sup>14</sup>. Berko (2001) found that madacide disinfections solution cause a significant reduction in the dimensional stability, compressive strength and surface hardness<sup>15</sup>.

The results of this study found no significant differences in compressive strength between the control and sprayed groups, this may be due to the fact that when a specimen is sprayed, it absorbs fewer amounts than if it immersed in the same solution so the amount of the free water left within the specimens of sprayed group will be less than that of the immersion group specimens which showed lower compressive strength even after (24) or (48) hours bench drying. The dental stone casts that were immersed in the disinfectant solution showed a higher surface roughness values, this could be attributed to some degree of dissolution of calcium sulfate dehydrate crystals at the surface. These results are in agreement with that of Rudd (1970) when he found that the increase in surface roughness values could be due to the etching effect of the disinfectant solution used in this study<sup>16</sup>.

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