Evaluate (0.2% CHX) Disinfection Solution Effects Incorporation on the Setting Time, Setting Expansion and Compressive Strength of Dental Stone

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Abstract This study aims to evaluate the effect of incorporation of 0.2% Chlorhexidine disinfection solution on the setting time, setting expansion and (wet and dry) compressive strengths of dental stone compared with these obtained control stone. The method included preparation of specimen and procedure were at 23±2ºC temperature and 50±10 relative humidity. The water/powder (W/P) ratio 100g of stone and 33ml of 0.2% CHX mixed for one minute with manual spatulation at rate 120rpm. It was found that 0.2% CHX solution increased the setting time for both types but this is increasing the clinically significant; then improvement in the dry and wet compressive strength for both types. Setting expansion was increased slightly for both types of stone but it with American Dental Associations (ADA) specification range 0.0-0.2%.

Key word: CHX, Setting time, Setting expansion, Compressive strength, Dental stone

1. Introduction

Gypsum products are used in several places in the dental field. These materials are possessing high mechanical properties, as high compressive stress, in order to withstand the working forces when used clinically. The gypsum products strength can be affected by many factors like, the water/powder ratio, additives, mixing time, etc.[1].

The most serious occupational hazards facing the dental professional are the possibility of contracting and/or sever infectious diseases transmitting. Diseases can spread by blood or saliva through directly or indirectly contact with contaminated equipment’s supplies, instruments, impression and casts which were proved that a potential source lamination of microbial ion. Therefore, when preparing, fabrication and handling prosthodontic restorations, additional precaution would be taken [2].

The incorporation of disinfections agent into stone mixture is the best one methods of cast disinfection. During dental procedure either clinically or laboratory, stone cast should be exposed to contamination in any time of using and may be repeated exposed to contamination. In such conditions, the cast would be re-disinfected after each contamination or as an alternative method is to use an agent of prolonged activity that is able to maintain self-disinfection against each contamination and serve as effective infection control program[3].
Disinfection of dental stone casts was suggested because of not all impression materials can be disinfected without adverse effects on the essential properties. Many studies influenced the antibacterial activity of some disinfectant used for disinfectant of stone casts. Among different disinfection methods, it was find that disinfectant incorporation was the best method due to it had double action to disinfection of the impressions in addition to casts[4].

Plaster models disinfection can be carried out by spraying or immersion in a disinfecting solution, in addition to by the incorporation of antimicrobial agents into the plaster mixture[5]. It was find that chlorhexidine solution maintained maximum compression strength, least setting expansion and little increasing of setting time, while glutar aldehyde showed the great increasing of setting time. Also it was find that high concentration of chlorhexidine had more effect on mechanical properties than low concentration, these methods were considered as high efficient and liable method of compared with immersion and spray methods, due to it permits equal antibacterial agent distribution throughout the mixture[6].

Disinfectant solution incorporation would not produce adverse effect on the physical or mechanical properties like compression stress, surface hardness, setting time, setting expansion and reproduction of detail due to deterioration in these properties will affect the dental treatment made on such cast[7].

Gypsum products are the most common materials that are used in dentistry widely and because of the high demand on this material. Efforts could be made to produce the material locally from local materials. Among the materials used in the dentistry is gypsum products, and it was one of the different of materials used by the dentist and dental technician[8, 9].

The aim of the study was to investigate the effect of incorporation of 0.2% CHX on the setting time, setting expansion and compressive strength of dental stone.

2. Materials and Methods

G1: Dental stone + distilled water.
G2: Dental stone + 0.2% CHX solution.

The preparation of 60 test specimens was at temperature environment 23+2°C and 50+10% relative humidity. Each 100g of stone powder was mixed with 33 ml of 0.2% CHX for Hi-stone and 38ml for Iraqi stone. 1 min. for mixing at rate 120rpm , followed ADA specification. Five specimens for each group were evaluated for each test.

2.1. Experimental tests

2.1.1. Setting Time Test

Setting time was measured by standard vicat apparatus (figure 1) according to A. D. A. specification No. 25 [10]. The conical mold was filled with stone mixture by adding 200g of stone powder to 66ml of CHX for experimental and distilled water for control stone. The needle was brought in contact with the surface of stone and locked in its position by thumb screw. At time of the loss of gloss, the needle was released at 15 seconds interval until the needle first failed to penetrate the stone completely.

2.1.2. Setting Expansion Test
Setting expansion device that consist of dial gauge and gauge rod was used (figure 2). Stone mixture was poured into the stainless steel mold of (28.5x2.5x2.5) cm (figure 3), and after 30 minutes the mold was disassembled. The stone specimen was placed into selling expansion device, the initial reading was obtained. After 2 hours the final reading was measured and setting expansion percentage was calculated.

2.1.3. Compressive Strength Test

Aluminum split molds 20mm in diameter and 40 mm height were filled with stone mixture. After 30 minutes from mixing, the specimens (figure 4) were kept in desiccators for 30 minutes at 23±2ºC temperature and 95±5% relative humidity. Compressive strength machine was used with loading rate of 600KN/min (figure 5). Wet strength after 1 hour, and dry strength after 24 hours were measured.

3. Results and Discussions

The effect of CHX disinfectant solution on the setting time, compressive strength and setting expansion of experimental stone and control stone are tested (table 1). Incorporation of chlorhexidine into stone mixture in different concentration was evaluated immediately after cast separation and after storage period. It was concluded that 0.2% CHX was enough to give proper disinfection for the dental stone[11, 12].

3.1. Setting Time

The result revealed that CHX disinfectant solution produced noticeable effect on the setting time of dental stone. Increased setting time was found by Al-Shakhily, 1995 for both concentrations of CHX solution (0.2,0.5%). Probably CHX solution act as retarder by either coat the particles of hemihydrates which inhibit the rate of solution or react with either the calcium or sulfate ions. Also retarder consists of salts, that form a layer of a calcium salt that is less soluble than the sulfate.

3.2. Setting Expansion

The percentage of setting expansion of two types of stone was shown. It was found that the incorporation of CHX disinfectant solution into stone mixture increased the setting expansion for both experimental and control stone than that found with distilled water [13]. Al-Shakhily, 1995 found that CHX increased the setting expansion. This is in contrast with [14, 15] who stated that the thicker the mix of hemihydrate, the greater the expansion. This higher expansion for new Iraqi stone might be due to dense and smaller size particle powder, leading to higher number of particles, thus higher summation of growth and higher expansion at the end. Also, higher expansion might be due to modifiers that added by manufacture [16]. Confirmed that the addition of sodium chloride (NaCl) in small concentration increase the setting expansion of mass. The A.D.A. specification recommended the accented range of (0.0%-0.2%) for setting expansion.

3.3. Compressive Strength
Incorporation of CHX solution produced an increase in the wet and dry compressive strength for both types of stones than that showed with distilled water [13]. Alshakhily, found that 0.5% CHX solution increase significantly the compressive strength of dental stone, this might be due to increase in cohesion between the crystals of dihydrate produced by CHX incorporation. Wet compressive strength (after 1 hour from mixing) for control stone was higher than value recorded for new experimental stone. Dry compressive strength (after 24 hours) decreased for experimental stone than control stone, since the higher w/p ratio, the more the porosity [14]. This reduction in wet and dry compressive strength is in agreement with [12, 16]. No significant difference in dry compressive strength between the two types of stone was recorded.

4. Conclusion
In was found that using 0.2% CHX solution increased the setting time for both types of stone, but this increase in setting time might be clinically significant. An improvement in the wet and dry compressive strength for control stone and experimental stone was found. A slight increasing in setting expansion for both types was detecting. Within A. D. A. specification ranges (0.0%-0.2%); CHX (0.2% concentration) can be used as disinfectant solution to be incorporated into stone mixture for cast disinfection.

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| Groups      | S. T. (min.) | S. Exp. (%) | Wet C. S. kg/cm² | Dry C. S. kg/cm² |
|-------------|-------------|-------------|------------------|-----------------|
| Group 1     | 16.52±0.5   | 0.07±0.008  | 358.62±10.43     | 613.29±8.48     |
| Group 2     | 25.81±0.4   | 0.11±0.007  | 302.74±14.42     | 595.75±14.99    |

*G1: Hi-stone+0.2 CHX*

*G2: Iraqi stone+0.2 CHX*
Figure 1: Standard vicat apparatus.

Figure 2: Setting expansion device.

Figure 3: Stainless steel mold and specimen of setting expansion test.

Figure 4: Compressive strength test specimen.

Figure 5: Compressive strength machine.