ASDJ
AINSHAMS DENTAL JOURNAL

Print ISSN 1110-7642
Online ISSN 2735-5039

AIN SHAMS DENTAL JOURNAL
Official Publication of Ain Shams Dental School
June2024 • Vol. 34

Effect of Dental Stone Fluidity Properties, Compatibility with Impression Materials, and Detail Reproduction after Incorporation of 0.2% Chlorhexidine Solution

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Aim: Evaluate the effect of incorporation of 0.2% CHX solution on the detail reproduction compatibility with impression materials, and fluidity of Iraqi stone comparing with Hi-stone.
Materials and Methods: W/P ratio 33ml/100g for Hi-stone and 38ml/100g for Iraqi stone. For detail reproduction detail test block which had 60-degree angle grooves width (0.025, 0.050, 0.075, 0.1, 0.2, 0.3) mm with cross line. Silicone, alginate, and zinc oxide eugenol (ZOE) used for compatibility with impression materials test (n= 10), after setting of impression material, poured with stone and scored. Fluidity was obtained with a different w/p ratio by a slump plate diameter.
Results: The mean reproduction of detail was 1.03 ± 0.4 Iraqi stone and 1.03±0.4 Hi-stones. The mean scoring with silicone of Hi-stone was 1.03±0.4 while Iraqi stone was 1.03±0.4. The mean diameter of the slump test was 99.0±1 with Hi-stone, a higher mean of 99.6±1.34 of new Iraqi stone.
Conclusion: 0.2% CHX improved the reproduction of detail ability of both types of stone, the same compatibility with silicone and alginate impression materials but less compatibility with ZOE for the two types of stone. Both stones demonstrated reasonable and similar fluidity.

Keywords: Chlorhexidine, Silicone impression, Alginate, Fluidity, Stone.

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Introduction

During taking a dental impression from patient's mouth it could be contaminated with patient's saliva, blood and plaque. Thus, dental impression could be susceptible to many oral pathogenic microorganisms that live in patient's oral cavity.[1] Rinsing the taken dental impression with water will reduce the microorganism but does not remove them all.[2] Some of pathogenic microorganisms will remain on the dental impression surface and cause a serious infection that may thread human life.[1,2] The contaminated dental impression will be poured with stone cast later and thus microorganisms will be transmitted to the stone, which may risks the dentist, dental assistant and laboratory technician to get a serious infection.[1,3,4]

Therefore, disinfect the impression before pouring and even disinfect the gypsum cast must be made with suitable disinfectant agents as recommended by the World Dental Federation (FDI) and the American Dental Association # 25 (ADA).[5,6] Many disinfectant solutions have been introduced for that purpose such as glutaraldehyde, phenols, chlorhexidine digluconate and penols. Moreover, many sterilization methods also has been used such as ultraviolet light chambers, autoclave and microwaves.[4,5,7] Many of these disinfectant solutions and sterilization methods minimize the cross-contamination but may also alter the dimensional stability of the dental impression and change the details properties and fluidity of the stone cast.[5,7] Hence, to get an accurate dental restoration, the used disinfectant solution must have effective antimicrobial agents and should not affect the detail properties, dimensional stability and surface texture of the impression and the stone.[4,6,8,9]

Chlorhexidine (CHX) is a member of the chemical bisbiguanide class, which is known for its bactericidal properties. When CHX is in commercial pesticide products indication, is mainly formulated as its diacetate, digluconate, and dihydrochloride salts.[6,10] Chlorhexidine, in the dental field, is one of the more commonly prescribed antiseptic agents due to its antimicrobial effect.[3,5,11] Therefore, it was used in many research and tests related to many dental industries. CHX for many decades was used and incorporated in many dental applications such as dental materials, disinfecting moist wounds, orthodontic appliances, mouth washes, root canal sealers and irrigation, restorative materials and dental implants.[12-15] Compared to other dental materials, gypsum products likely provide the dentistry industries with the best results, due to its multipurpose with low changes in the material properties.[16] Despite gypsum products are indirect dental indication restorative material, which they still considered as very important adjunctive materials that utilized in wide range of procedures of the dental laboratory.[17]

By employing models and dies, dental restorations and appliances are created away from patients' mouths that represent a positive replica of teeth and/or oral structures, therefore they must have enough strength without being distorted or broken to withstand the different laboratory steps.[18,19] The cast disinfection became an important procedure for obtaining no contaminated casts, because of the potential transference of infectious agents by the patient's blood or saliva situated in the impression for the cast, thus establishing control procedure of cross-contamination.[20] The plaster model's disinfection can be carried out through spraying, immersion in a disinfectant solution or incorporation of antimicrobial agents with the plaster mass. However, immersions of casts have been related by some authors as being deleterious to the final qualities of the casts as spraying them with

disinfecting solutions has not presented any harmful effect on the plaster cast surfaces.[21]

One of the main disinfectant solution requirements relates with the ability to fight off a variety of microbes, including bacteria, viruses, or fungus, while simultaneously preventing them from affecting the mechanical or physical properties of the impression material or cast properties. Moreover, it would be inexpensive, not harmful to tissues in humans and easy to be used.[5,22] The new Iraqi dental stone passed the ADA specification for dental stone and could be successfully used in dentistry. Hence, is used in this study to be compared to the Hi-stone (control group).[3,23]

The purpose of the research is to assess the impact of adding 0.2% CHX liquid on the reproduction of detail compatibility with impression materials, and fluidity of Iraqi stone comparing with Hi-stone (control group).

Materials and Methods

The pilot study has been made to select the perfect chlorohexidine (dentalLife, Australia) ratio before performing this study. The used ratios were; 0.1% CHX, 0.2% CHX, 0.3% CHX and 0.5% CHX. 0.1% CHX showed no negative effect on the stone properties but gave low disinfection properties. CHX, 0.3% CHX, and 0.5% CHX gave perfect disinfection effect but changed the stone properties. 0.2% CHX was perfect ratio that gave good disinfection effect and did not change the stone properties compared to the above-mentioned ratios. Hence, 0.2% CHX was selected to be used in this study. At a temperature of 23±2 °C as well as an average humidity of 501±0%, samples for testing were prepared. Following ADA specifications, 100 g of stone powder were manually blended with 33 ml of 0.2 CHX for Hi-stone and 38 ml for Iraqi stone for one minute at a speed of 120 rpm (24). For every experiment, five samples from each group are examined.

Reproduction of Detail Test

A stainless-steel test block was made according to the ADA specification that had 60-degree angle grooves width: 0.025 mm, 0.050 mm, 0.075 mm, 0.1mm, 0.2 mm, and 0.3 mm with the cross line along the test block. A copper ring of 20 mm height and 30 mm in diameter was used for specimen preparation (Figure 1). Samples groups are listed in Table 1.

The criteria for evaluation were as follows:

Score I: 0.050 mm line was continuing over the ring's whole width.

Score II: 0.050 mm line was continuous for more than half of the ring.

Score 111: The continuity of 0.050 was less than half of the ring.

Score IV: Reproduction of 0.050 mm fail along the width of the ring.

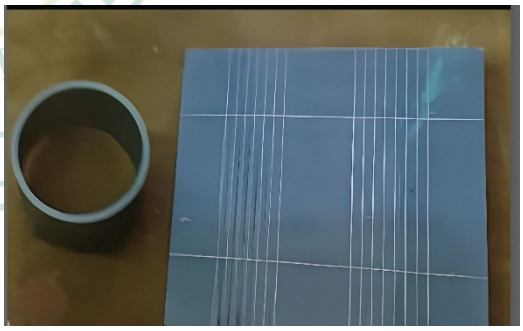

FIGURE 1: Stainless-steel test block with coper ring for reproduction of detail test

Table 1: Samples groups in reproduction of detail test and Consistency test

Group	Materials
Gl	Hi-stone+ 0.2 % chlorohexidine (n=10)
G2	Iraqi-stone+ 0.2 % chlorohexidine (n=10)

Compatibility with Impression Materials Test

Three types of impression materials were used (Alginate (alginelle, Lascod, Italy), ZOE (SS white group, England), and Silicone (Zhermack Catalyst Indurent gel + Zhermack Oranwash Light Body. Italy) according to the ADA Specification # 25. A stainless-steel test block and a copper ring (Figure 2) were used. Samples groups are shown in Table 2. When complete setting of impression material happens, all rings were poured with stone and scored after removing from impression as follows:

Score 1: A 0.050 mm line that is distinct and acute runs the whole breadth of the specimen.

Score II: 0.050 mm line was lost some of the sharpness.

Score III: There is a break in the 0.050 mm line's continuity.

Score IV**:** Reproduction of the 0.050-mm line fails.

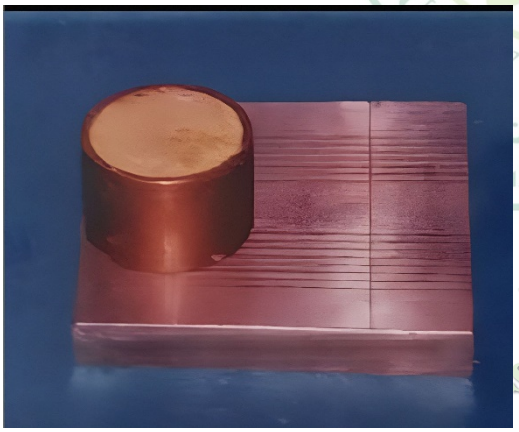

FIGURE 2: Stainless-steel test block, coper ring with stone of compatibility with impression materials test

Tale 2: Samples groups in Compatibility with Impression Materials test

Group	Subgroups		
Gl (Hi-stone+ 0.2 % chlorohexidine)	Silicone (n=10)	Alginate (n=10)	ZOE (n=10)
G2 (Iraqi-stone+ 0.2 % chlorohexidine)	Silicone (n=10)	Alginate (n=10)	ZOE (n=10)

Fluidity Test

Testing fluidity was obtained with different w/p ratios by a slump path diameter according to Iraqi and British Specifications 1991.[2] 50 mm length and 35 mm in diameter cylindrical mold and smooth ceramic plate with 100 mm in diameter were used (Figure 3). 75g of stone powder was added to gauging 0.2 CHX. After two minutes. from the start of mixing, the mold (after poured with mixture) left vertically at a rate of 10 mm/sec. Measured the major and minor diameter of slump mix by vernier and taking the average of diameters as a measure of fluidity. In this test, samples were grouped into two groups as shown in Table 1.

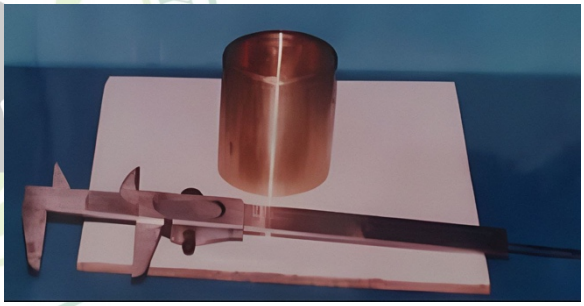

Figure 3: Ceramic plate, ring and Vernier for consistency test

Results

The obtained data was statistically analyzed using one-way ANOVA and the T-tests, respectively. 0.2% CHX disinfection solution's impact on the reproduction of detail, compatibility with different impression materials, and fluidity of new Iraqi stone and Hi-Stone are tested in this research in (Table 3).

Table 3: The Effect of 0.2% CHX Disinfectant Solution on the Physical and Mechanical Properties of Iraqi Stone and Hi-stone (Mean and Standard Deviation)

Group	Reproduction of Detail (mean)	Compatibility with Impression Materials (mean)			Consistency (mm)
		Silicone	Alginate	ZOE	
Gl	1.03±0.4	1.03±0.4	1.31±0.03	1.21±0.04	99±1
G2	1.03±0.4	1.03±0.4	1.29±0.04	1.14±0.03	99.6±1.3

Discussion

Reproduction of Detail

T-test showed no significant difference between new Iraqi stone and Hi-stone. The scoring given to every stone specimen observer was in perfect harmony with other observers. The mean reproduction of the detailed test was 1.03 ± 0.4 for new Iraqi stone, and 1.03±0.4 for Hi-stone (as listed in Table 3) which was obtained from 60 assessments to each stone. Results in this study has proved that Chlorhexidine solution in 0.2% concentration improved the reproduction ability of Hi-stone and new Iraqi stone in comparison with distilled water used.[18] This improvement is in agreement with Lucas et al [25] who found that 0.5% CHX improved the reproduction ability of dental stone and provide excellent duplication of detail for both types of stone. This result indicated a suitable combination of dental stone and CHX disinfectant solution.

In addition, a research[3] was made to evaluate the effect of antimicrobials agents, alongside the mechanical and surface properties of gypsum mixed with 2% chlorhexidine and self-disinfecting gypsum. Results showed that reproduction ability of gypsum mixed with stone has better results compared to self-disinfecting gypsum group. At which that was in agreement with the result of this study. Dulaimi SF et al.[1] have also tested the surface quality of different types of gypsum and impression materials disinfected with various disinfectant solutions. They showed that there were better results in gypsum and impression groups disinfected with chlorohexidine compared to those disinfected with sodium hypochlorite. That also supported the results of the current study. Results of this study were fall within the specification values of American Dental Association #25.

Compatibility with Impression Materials

T-test showed no significant difference between them. The differences in physical properties of impression materials and their compatibility to gypsum indicated vary in the quality of the surface of dental stone casts they poured into.[26] 120 assessments were made for both Hi-stone and new Iraqi stone for every impression material by four observers. There was close agreement between the assessments of the four observers that lead to the sum of their assessment for every different impression materials of each stone type (as explained in Table 3). The mean scoring with silicone impression material for Hi-stone was 1.03±0.4 while for new Iraqi stone was 1.03±0.4.

The mean scoring with zinc oxide eugenol impression material for new Iraqi stone was 1.14±0.03, while for Hi-stone was 1.21±0.04. The significant difference was obtained between them. The mean scoring with alginate impression material revealed less compatibility with both types of stone as indicated by the higher mean scoring. The scoring mean of new Iraqi stone was 1.29±0.04 and for Hi-stone was 1.31±0.03. No significant difference was found between them.

These results were in agreement with many studies made by Johansson, E. G., *et al*.[26] and Dulaimi SF., *et al.*[1] 0.2% CHX solution improved the compatibility with silicone and alginate impression materials but reduced the compatibility with zinc oxide eugenol in comparison with distilled water.[27] Higher mean scoring for this impression material with CHX than with distilled water indicates this.

Fluidity

The fluidity test for stone was determined according to British standard and Iraqi Standard No. 27 for gypsum products. The mean diameter of the slump test was

99.0±1 for Hi-stone, while a higher mean 99.6±1.34 for new Iraqi stone (as listed in Table 3). This might be due to the higher w/p ratio of 0.38 compared to Hi-stone 0.33, which increased in the fluidity of the mix, consequently, increase slump diameter. Besides, the increase in diameter for the slump test is in agreement with Paffenbarger[24]. Moreover, it might be due to modifiers added by manufacture like sodium citrate that increase the fluidity and reduce viscosity through a great area of the slump.

The analysis of data by T. test showed no significant difference between them. Both types of stone were within an acceptable range of Iraqi specification 100±3 mm. As a result of this study mean fluidity of both types of stone with 0.2% CHX showed a slight decrease in slump diameter in comparison with stone mixed with distilled water 99.80±2.39 mm Hi-stone and 100±1.58 mm with new Iraqi stone.[27] This might be due to CHX that increases the viscosity of stone, consequently, decrease slump diameter.

In general, to reduce the cross-contaminations in dental laboratories and dental clinics with minimum effect on the stone cast and impression materials properties, 0.2% chlorohexidine is preferred to be used wither by adding it to the stone cast or to the dental impression materials as proved in this study and agreed by many recent studies[3,5,6] . This result is in agreement with Dulaimi SF., et al[1] which evaluated the effect of 0.525% sodium hypochlorite, 0.2% Chlorehexidine Gluconate, and 4% Povidone Iodine on the surface quality and detail properties of impression materials and the resultant gypsum. They proved that chlorohexidine has no significant effect on the detail properties, dimensional accuracy and surface textures of the impression materials and gypsum cast.

The clinical significance of this study is highlighting the importance of using disinfectant agents to minimize the infection that could be happened between the dentist and laboratory technician. Limitations and recommendations of the study; 0.2% CHX solution was used in this research, authors recommend to use 0.2% CHX as a powder and add it to stone materials and check withier gives better results or not. Microbiological test to check the chlorohexidine effect on the oral cavity microorganism is advised to be made in the future studies.

Conclusions

The study showed that 0.2% CHX improved the reproduction of detail ability of both types of stone and produced fine details that have a favorable effect on the surface quality of the stone. The compatibility with silicone and alginate impression materials was better compared to that of zinc oxide eugenol with the two types of stones. Hi-stone and new Iraqi stone demonstrated reasonable and similar fluidity. CHX is a disinfectant that may be added to a stone mixture for disinfecting casts at a concentration of 0.2%.

Acknowledgments

The facilities at Al-Maarif University College in Al-Anbar are acknowledged by the writers, who are also appreciative of the department of dentistry staff's assistance in practice.

Ethical Approval

Because this research was conducted using samples unrelated to humans or animals, ethical approval was not necessary.

Conflicts of interest

The authors have no conflict of interest relevant to this article.

Funding

No fund from any organization were received for this research. Authors were self-funded in this research.

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