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Original Research

Evaluation of Different Disinfactants on Dimensional Accuracy and Surface Quality of Type IV Gypsum Casts Retrieved from Elastomeric Impression Materials

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***Abstract*:**

Background: The present study was done to evaluate the dimensional stability and surface quality of Type IV gypsum casts retrieved from disinfected elastomeric impression materials.

Materials and Methods: In an *in vitro* study contaminated impression material with known bacterial species was disinfected with disinfectants followed by culturing the swab sample to assess reduction in level of bacterial colony. Changes in surface detail reproduction of impression were assessed fallowing disinfection.

Results: All the three disinfectants used in the study produced a 100% reduction in colony forming units of the test organisms.

Conclusion: All the three disinfectants produced complete disinfection, and didn't cause any deterioration in surface detail reproduction.

Key Words: Disinfectants, elastomeric impression materials, surface reproducibility

Introduction

During routine dental procedures, dental professionals are exposed to various microorganisms from blood and saliva either directly or indirectly such as using contaminated equipments or impression materials. Majority of these organisms results into significant risk to dental professionals, such as hepatitis, human immunodeficiency virus, etc.[1]

Impression making is a primary step in prosthesis design. Contaminated impression material is a principal route of transmission of infection from patient to dental personnel.[2,3] Hence, it is mandatory to practice disinfection procedure to prevent, transmission of pathogens from an infected individual to a susceptible host.[2] Rinsing removes organic matter and reduces virus and bacterial load.[3] Washing alone in water removes only 40-90% of bacteria.[3] The commonly used and preferred method of disinfecting impression materials is by using chemical disinfectants. Commonly used disinfectants are 0.5% sodium hypochlorite (NaOCl), 2% glutaraldehyde, which are effective against both Gram-positive and Gram-negative microorganisms.[1]

American Dental Association (ADA) council in 1996 and FDI in 1998 recommends disinfection of impression materials by immersion or spray procedure for 2-3 min.[2,4] The disinfecting process should be proper, but should not have an adverse effect on the dimensional stability and surface details reproduction of impression.[5]

However studies available on efficacy of disinfectants and surface reproducibility are very scares; hence, the study was undertaken with fallowing aims and objectives; (1) to evaluate the effectiveness of three disinfectants in reducing colony forming units of *Staphylococcus aureus, Pseudomonas aeruginosa* and *Escherichia coli* on addition silicon impression material, (2) to evaluate the effect of immersion disinfection of elastomeric impression on the surface detail reproduction of Type IV gypsum cast.

Materials and Methods

This study was conducted in two parts; (1) to evaluate the effectiveness of three commonly used disinfectants (2% alkaline glutaraldehyde, 4% NaOCl and 1% NaOCl) during immersion disinfection of elastomeric impression material and (2) to study the effect of immersion disinfection of elastomeric impressions on the surface detail reproduction of Type IV gypsum casts. 40 samples were equally divided into 4 groups; (1) 1% NaOCl, (2) 4% NaOCl, (3) 2% alkaline glutaraldehyde, and (4) distilled water as a control group.

Part-I

To evaluate the effectiveness of three commonly used disinfectants, impressions were made of a sterile typodont model of the maxillary arch that was contaminated separately with *S. aureus* ATCC 6538, *P. aeruginosa* (drug resistant hospital strain) and *E. coli* ATCC 25922. The impressions

were cultured before and after immersion in 2% alkaline glutaraldehyde, 4% sodium hypochlorite, 1% NaOCl (Figure 1), and sterile distilled water were used as control. The impression was then rinsed slowly for 45 s with 250 ml of sterile water in accordance with ADA recommendations (Figure 2). Viable bacterial transfer was done by culturing the impression sites (occlusal surfaces, cusp tips or incisal edges) from the left maxillary central incisor to the left maxillary second premolar of the arch with a sterile swab. These cultures were plated onto blood agar (*Staphylococcus auresus),* and MacConkey's agar (*E. coli* and *P. aeruginosa)* and incubated aerobically at 37°C for 48 h (Figure 3). Then change in colony forming units was noted.[2,4]

Part-II

The test apparatus consisted of a brass piston (cylindrical plunger) and a circular die. Both the die and piston were of a tight fit and incubated (Figure 4), the lines were engraved perpendicular to the surface finish. A surface finish of 3.2 μm was achieved by using rubber bonded grinding wheel. Surface finish was inspected and measured using a GAR-B 1 inspection machine.

After an impression was made the impression material mold was retrieved and the surface of the imprint was examined for completeness of the reproductions to the reference surface without magnification. The impression was then pressed from the impression material mold (cylinder) into an exact wax replica of the cylinder for placement of the improved die stone. Impression was rinsed for 45 s, and then immersed in a disinfectant solution to wet all surfaces for the prescribed 10 min. The control impressions were immersed in distilled water for the time allotted for the immersion disinfection.[2,4]

After the disinfection procedure, the impression was rinsed for 45 s in distilled water, dried by forced air for 10 s and permitted to bench set for 10 min before it was cast in a Type IV dental stone (Type IV, Denflow, India). The stone cast was examined under low angle illumination with a magnification of 10 using a stereomicroscope (Leica, Switzerland) (Figure 5).

In this study, the 120 and 60 μm lines were evaluated. The dental stone poured against the impression specimen has to reproduce the entire length of the scribed lines to

Figure 1: Disinfectant used-alkaline glutaraldehyde and sodium hypochlorite.

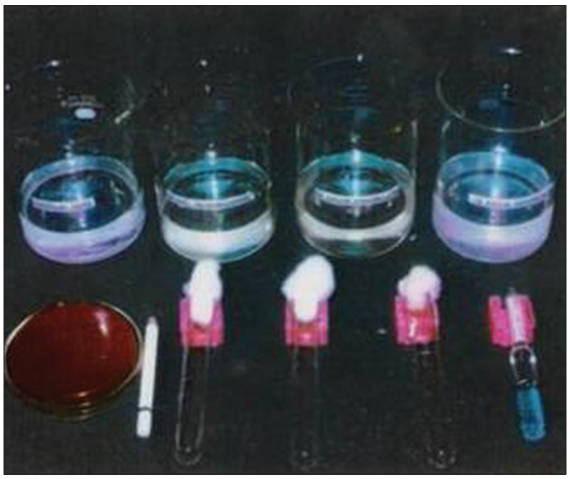

Figure 3: Maclarland opacity tube no.5 with equipments for culturing.

Figure 2: Maxillary impression samples.

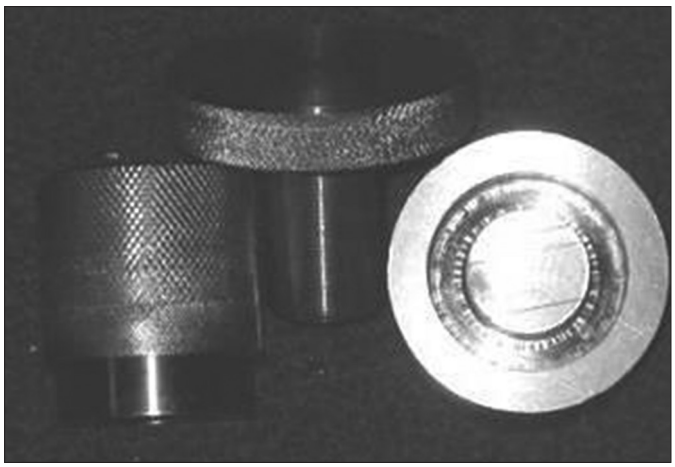

Figure 4: Stainless steel die, cylinder and piston.

pass the details reproduction test. The gypsum specimens were examined under low angle illumination at ×20 and ×40 magnification for the 120 and 60 μm lines with a stereomicroscope. Four standardized photographs (Figure 6) served as a reference to the rate of the stone specimens.

Rating 1: Well-defined sharp continuous line
Rating 2: Continuous line but with some loss of sharpness
Rating 3: Significant deterioration of edge detail or loss of continuity of line
Rating 4: Failure to reproduce the line.

Results were tabulated, and statistical analysis was done with ANOVA test.

Results

As shown in Table 1, it was found that all the three disinfectants used in the study produced a 100% reduction in colony forming units of the test organisms. This value is above the standard set values of disinfection which was 99% ($P < 0.01$).

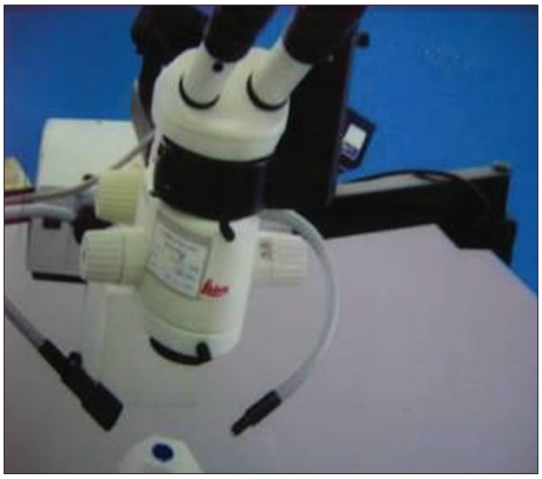

Figure 5: Stereomicroscope.

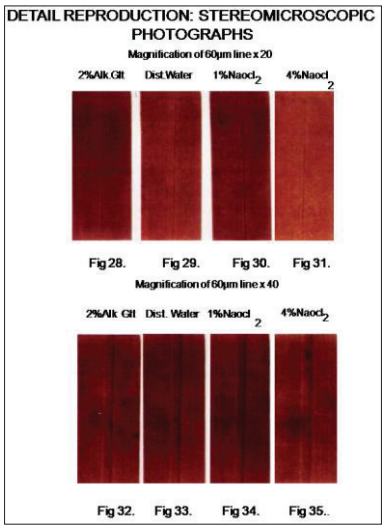

Figure 6: Detail reproduction: Stereomicroscopic photographs. Field at ×20 (2% alkaline glutaraldehyde).

When Part II results were tabulated (Tables 2 and 3) with the same Type I addition silicone and Type IV die stone, observed under a similar magnification for surface detail reproduction by two different evaluators (×20 and ×40 magnification) (Figure 6).

A total of 60 μm lines showed great variation in surface detail reproduction from the larger lines giving a mean of 1.5-2.75 in ratings. Of this 4% NaOCl disinfected impressions had a rating of 3 which showed significant deterioration of edge and loss of continuity of the 60 μm line. Those impressions immersed in sterile distilled water had better rating of 2, which was continuous but has loss of sharpness. One important finding was that 1% NaOCl group gave the best rating of surface detail (Rating 1, by mode) where the line was well-defined sharp and continuous. 4% NaOCl group even after a through rinse in purified water showed a visible film of disinfectant.

Table 1: Net % reduction in colonies of all test organisms.

Disinfectant	*Staphylococcus aureus*	*Pseudomonas aeruginosa*	*Escherichia coli*
1% NaOCl	100	100	100
4% NaOCl	100	100	100
2% alkaline glutaraldehyde	100	100	100
Sterile distilled water	82.9	85.78	95.86

NaOCl: Sodium hypochlorite

Table 2: Rating scores for detail reproduction of 120 μm line.

Specimen number	Evaluation 1	Evaluation 2	Mode
2% alkaline glutaraldehyde			
1	1	1	1
2	1	1	
3	1	1	
4	1	1	
5	1	1	
4% NaOCl			
6	1	1	1
7	1	1	
8	1	1	
9	1	1	
10	1	1	
1% NaOCl			
11	1	1	1
12	1	1	
13	1	1	
14	1	1	
15	1	1	
Distilled water			
16	1	1	1
17	1	1	
18	1	1	
19	1	1	
20	1	1	

Rating 1: Well-defined, sharp, continuous line. Rating 2: Continuous line but with some loss of sharpness. Rating 3: Significant deterioration of edge detail or loss of continuity of line. Rating 4: Failure to reproduce the line. NaOCl: Sodium hypochlorite

Table 3: Rating scores for detail reproduction of 60 µm line.

Specimen number	Evaluator 1	Evaluator 2	Mode	Mean	±SD	F value	*P* value
2% alkaline glutaraldehyde			3				
1	2	3		2.75	0.5	1.417	*P*>0.05
2	3	2					
3	2	3					
4	3	2					
5	2	3					
4% NaOCl			3	2.25	0.5		
6	3	2					
7	3	2					
8	3	3					
9	2	3					
10	2	3					
1% NaOCl			1	1.5	0.57		
11	1	1					
12	2	2					
13	2	1					
14	1	2					
15	1	1					
Distilled water			2	1.5	0.57		
16	2	2					
17	2	1					
18	1	2					
19	1	2					
20	1	2					

Rating 1: Well-defined, sharp, continuous line. Rating 2: Continuous line but with some loss of sharpness. Rating 3: Significant deterioration of edge detail or loss of continuity of line. Rating 4: Failure to reproduce the line. NaOCl: Sodium hypochlorite

Discussion

The impression material can act as a vehicle for transmission of microorganisms.[2] Thus, there is a need of effective media for prevention of cross contamination. Disinfection of impression should not alter the surface detail of the impression. Rowe and Forrest (1978) suggested that, rinsing under water did not clear away all the blood and saliva from the impression surface.[6] It has been observed that retention of microorganisms on irreversible hydrocolloids impression is 2-3 times greater than other material.[3]

The three microorganisms selected for the represent study such as; *P. aeruginosa* and *S. aureus* and *E. coli* which are known for resistance to various commonly used physical and chemical methods of disinfection.[1] *S. aureus* is used as it is more resistant of non sporing bacteria. They retain their viability for up to 3-6 months and withstand temperature of 600 C for 30 min.[1]

An ideal disinfectant should be capable of rapidly killing pathogenic microorganisms and should not be toxic or destructive to the materials disinfected. It should be reasonably priced and simple to use. Routinely used chemical agents suitable for disinfection of impression material are NaOCl, iodophor, phenol, chlorine solutions, formaldehydes, and glutaraldehydes.[4,7] Sukhija *et al.* (2009) concluded that peracetic acid was more effective than other materials.[3]

In the present study, 4% and 1% NaOCl and 2% alkaline glutaraldehyde disinfectants were used as disinfectants and distilled water as a negative control group. Each of these disinfectants varies in their mode of action and effectiveness.

NaOCl (prime dental product) is economical and effective in dilute solutions. The antimicrobial action is rapid. Since it has little or no negative effect on gypsum when used in a 1% concentration and may actually improve surface detail reproduction. Doddamani *et al.* observed NaOCl most effective than glutaraldehyde.[1] Advantages of NaOCl are least expensive, readily available, 100% effective and fast acting broad spectrum disinfectant according to ADA's protocol.[1] Minagi *et al.* (1986) observed that hypochlorite at low concentration acts as an anti-adhesion for *Candida* species and NaOCl was found sufficient to control the virulent effect of *Candida* species.[8]

Glutaraldehyde is considered as a high level disinfectant that eliminates spores, bacteria, fungi, and viruses.[7] Glutaraldehyde and NaOCl reduces microorganisms, this is in agreement with studies done by Samra and Bhide (2010).[2]

It has been observed that immersion is better than spry for disinfection, while immersion is time consuming. Samra and Bhide observed that concentration of microorganism was almost two folds in the alginate group as compared to the addition silicone group.[2]

After immersion, all the three disinfectants produced 100% reduction in colony forming units of the test organisms,

which is compatible to other studies study.[1,2] The percentage reduction in colony forming units after rinsing the impressions with sterile distilled water varied between 82% and 96%. This was below the goal set for disinfection. Thus, rinsing with sterile distilled water did not disinfect impressions.

Dimensional accuracy and surface detail reproduction properties are necessary for a true copy of anatomical structure.[7] Saber *et al*. (2010) observed the largest dimensional changes (0.4%) that occurred during the disinfection process, and Saber *et al*. observed 0.1-0.4% dimensional changes, while Saber *et al*. and Guiraldo *et al*. (2012) observed no significant dimensional changes. According ADA specification elastomeric impression materials should not produce more than 0.5% of dimensional changes. Spray disinfection causes lesser dimensional changes than immersion method.[5,7] Many alginate manufacturers recommended that impression must be poured within 12 h since increased dimensional changes occur after 12-24 h.[7] The study by Johnson *et al*. proved that addition silicone impressions in combination with acid potentiate glutaraldehyde contributed to an improvement in surface qualities of the resulting stone dies.[9] Ahila *et al*. (2012) showed no significant dimensional changes fallowing disinfection of silicone impressions.[4] During the detail, reproduction evaluation of 120 μm line, consistent rating of 1 was recorded for all specimens. The 120 μm line on the cast was well-defined, sharp, and continuous (Table 2).

2% alkaline glutaraldehyde and 4% NaOCl disinfected impressions produced casts that have similar surface detail reproduction rating of 3, for the 60 μm line, In these casts the 60 μm line showed significant deterioration of edge detail or loss of continuity of line.

Impressions immersed in distilled water gave casts in which the detail reproduction of the 60 μm line was better and a rating of 2 recorded. The 60 μm line was continuous, but with some loss of sharpness. Impression immersed in 1% NaOCl gave casts in which the detail reproduction of 60 μm line was best and the rating of 1 was recorded. The 60 μm line was defined, sharp, and continuous (Table 3). From the above discussion, it is evident that selection of the type of impression material is more important than the selection of the disinfectant.

Conclusion

All the three disinfectant produced complete disinfection by a 100% reduction in colony forming units, and in the control group (distilled water) there was only 82-95.86% reduction. None of the disinfectants used, causes any deterioration in detail reproduction of the 120 μm line. Hence, the use of disinfectants to disinfect impression material is effective.

References

1. Doddamani S, Patil RA, Gangadhar SA. Efficacy of various spray disinfectants on irreversible hydrocolloid impression materials: An *in vitro* study. Indian J Dent Res 2011;22(6):764-9.
2. Samra RK, Bhide SV. Efficacy of different disinfectant systems on alginate and addition silicone impression materials of Indian and international origin: A comparative evaluation. J Indian Prosthodont Soc 2010;10(3):182-9.
3. Sukhija U, Rathee M, Kukreja N, Khindria S, Singh V, Palaskar J. Efficacy of various disinfectants on dental impression materials. Internet J Dent Sci 2009;9(1):1-6.
4. Ahila SC, Subramaniam E. Comparative evaluation of dimensional stability and surface quality of gypsum casts retrieved from disinfected addition silicone impressions at various time intervals: An *in vitro* study. J Dent Oral Hyg 2012;4(4):34-43.
5. Saleh Saber F, Abolfazli N, Kohsoltani M. The effect of disinfection by spray atomization on dimensional accuracy of condensation silicone impressions. J Dent Res Dent Clin Dent Prospects 2010;4(4):124-9.
6. Rowe AH, Forrest JO. Dental impressions. The probability of contamination and a method of disinfection. Br Dent J 1978;145(6):184-6.
7. Guiraldo RD, Borsato TT, Berger SB, Lopes MB, Gonini-Jr A, Sinhoreti MA. Surface detail reproduction and dimensional accuracy of stone models: Influence of disinfectant solutions and alginate impression materials. Braz Dent J 2012;23(4):417-21.
8. Minagi S, Fukushima K, Maeda N, Satomi K, Ohkawa S, Akagawa Y, *et al*. Disinfection method for impression materials: Freedom from fear of hepatitis B and acquired immunodeficiency syndrome. J Prosthet Dent 1986;56(4):451-4.
9. Johnson GH, Drennon DG, Powell GL. Accuracy of elastomeric impressions disinfected by immersion. J Am Dent Assoc 1988;116(4):525-30.