Research Article

JRAD Journal of Research and Advancement in Dentistry

J Res Adv Dent 2017;6:1s:202-208.

An In-Vitro Study to Determine the Efficacy of Disinfectant Solutions on Irreversible Hydrocolloid and Evaluation of Dimensional Accuracy of the Resultant Gypsum Cast

Pawanjeet Singh Chawla[1*] Esha Shah[2] Shweta Saini[3] Ankit Mehrotra[4]

[1]Reader, Department of Prosthodontics, Rama Dental College, Kanpur, UP, India.
[2]Senior Lecturer, Department of Prosthodontics, Rama Dental College, Kanpur, UP, India.
[3]Ex Post Graduate Student, Department of Prosthodontics, Rama Dental College, Kanpur, UP, India.
[4]Senior Lecturer, Department of Prosthodontics, Rama Dental College, Kanpur, UP, India.

ABSTRACT

Aim: To evaluate the antimicrobial efficacy of four commercially available disinfectants and their resultant effect on the dimensional accuracy of the cast poured after irreversible hydrocolloid impression material was immersed for 10 minutes.

Materials and Methods: Four different type of disinfectants (2% Glutaraldehyde (CIDEX), 0.525% Sodium hypochlorite (RANKEM), 5% Phenol (LABSAFE), 1.75% Iodophor (D – 125) were used. Alginate (Neocolloid) was used as an impression material. Impressions made were painted with bacterial colony and immersed in respective disinfectant and antimicrobial efficacy was observed after culture and gram stain. Dimensional accuracy of the cart poured after immersion was determined by verneer caliper. The data were analyzed by (ANOVA - One Way Analysis) and $P<.05$ was regarded as significant.

Results: Regardless of the disinfectant used, there was absence of microbial growth on incubation after immersion for 10 min. It was observed that, least dimensional change occurs in the casts when disinfected with 2% glutaraldehyde and most when immersed in 0.525% sodium hypochlorite. There was least variance for 5% Phenol solution whereas highest for the 0.525% sodium hypochlorite solution. There is statistically significant difference between the mean cross-arch distance from one level disinfected casts to another by a value of 0.221500.

Conclusion: The results of this study indicated that all the four disinfectants were effective against the selected bacterial species viz. Candida albicans, Streptococcus mutans, Staphylococcus aureus. Casts obtained from disinfected impressions showed significantly good dimensional accuracy compared to the master model. Partial deterioration of Neocolloid was found following immersion in 0.525% sodium hypochlorite leading to poor surface quality of the resultant casts.

Keywords: Antimicrobial, Impression material, Disinfectants, Immersion.

INTRODUCTION

Impression materials are used to make accurate negative replicas of the oral hard and soft tissues. Impression making is considered as one of the most important steps in prosthodontics and a plethora of materials are available for this purpose. Each of these materials has certain advantages and

Received: Jan. 11, 2017: **Accepted:** Mar. 2, 2017
*Correspondence Dr. Pawanjeet Singh Chawla.
Department of Prosthodontics, Rama Dental College, Kanpur, UP, India.
Email: drpoonamm.singh@gmail.com

pISSN 2278-0076
eISSN 2321-9270

disadvantages. An understanding of the physical characteristics and limitations of each material is necessary for its successful use in clinical dentistry. Irreversible hydrocolloid is the most popular impression material in everyday practice as it fulfils most of the requirements of an ideal impression material including acceptable elastic properties, easy manipulation, comfortable for patients, relatively inexpensive and does not need elaborate equipment. Cross infection may be defined as the transmission of infectious agent, among patient and staff within a clinical environment either through direct contact or via contaminated objects. Transmission of infection requires:-

a. A source of infection
b. A route of transmission

Proper disinfection .of impression should be done by dental lab to render it safe for further handling without affecting the accuracy of fine details, e.g. in Hydrocolloids:- disinfection procedures should be relatively rapid to prevent dimensional change due to its partly organic, hydrophilic, irregular and porous nature.[1] During routine prosthodontic treatment, mycobacterium tuberculosis, E. coli, Alpha – hemolytic streptococci, H.I.V, Hepatitis B virus, Herpes simplex virus and other opportunistic and pathogenic micro – organism can be transmitted through impressions.[2] Infection control has therefore become one of the most discussed topic in dentistry today.[3] As dental personnel are becoming aware of the risk of transmission of infection by blood and saliva from contaminated impressions, research is evolving that relates directly to these previously neglected disciplines.[4] Sterilization of dental instruments and disinfection of worktops and equipment's have been elaborately described in literature to avoid cross – infection.[5]

The standard procedure of rinsing the impression under water immediately after removal from mouth eliminates gross contamination along with most of the saliva clinging to the impression. However, all micro – organisms are not removed by rinsing alone[6,7] and these residual micro – organisms can still be a source of infection as they can exist for extended periods outside their human hosts. Disinfection is a lethal process intended to kill disease producing microorganisms, but not the bacterial spores. It includes a broad range of activity, depending on disinfectant used and treatment time.[8] The method for disinfecting impression should be simple, not time consuming and non – toxic to human tissues and should obtain a safe impression without producing adverse effects on the properties of the impression material. Some methods of disinfection are:-

1) Immersion of impression (2% glutaraldehyde, 1% sodium hypochlorite)[5]
2) Spraying (Sodium Hypochlorite spray, 2% glutaraldehyde, iodophor)[6,9-12]
3) Short term submergence or drunking (2% acid glutaraldehyde, 1% povidine iodine)[13]
4) Incorporation of antimicrobial agents into powder of impression materials (didecyl dimetyl ammonium chloride)[4,14]
5) Inclusion of disinfectants into dental gypsum cast material (0.25% chloramine – T, iodophor)[15,16]

It is known that the intrinsic antibacterial and antifungal activity of disinfectant impregnated irreversible hydrocolloid is insufficient to prevent bacterial colonization of the impression surface[4], so disinfection of impressions is a must. Therefore, the present study was designed to evaluate the antimicrobial efficacy of four commercially available disinfectants and their resultant effect on the dimensional accuracy of the cast poured after irreversible hydrocolloid impression material was immersed for 10 minutes.

MATERIALS AND METHODS

Four different type of disinfectants (2% Glutaraldehyde (CIDEX), 0.525% Sodium hypochlorite (RANKEM), 5% Phenol (LABSAFE), 1.75% Iodophor (D – 125) **(Figure 1)** were used in this study. Holes were made using flat end taper bur on the mesio buccal cusp of 16 and 26 of the typhodont model **(Figure 2)** and ten Alginate (NEOCOLLOID) **(Figure 3)** impressions were made which were then were painted with bacterial colony **(Figure 4 and 5).** Then a sterile cotton swab was wiped on one of the infected impression (control for bacterial colony) **(Figure 6)** and was subjected to culture and sensitivity tests. Then all ten impressions were immersed in a sealed plastic bag containing disinfecting solution (5% Phenol) for 10 minutes **(Figure 7)**.

The same procedure was repeated for 2% Glutaraldehyde, 0.525% Sodium hypochlorite, 1.75% Iodophor disinfecting solutions. After 10 minutes using a sterile cotton swab the impressions were wiped **(Figure 8),** subjected for culture and sensitivity test and were poured. The casts were removed from the impressions after 45 minutes and were then divide into 4 groups – A, B, C, D depending on the disinfectants used, each containing 10 impressions each.

1) Group A: - 2% Glutaraldehyde solution for 10 minutes.
2) Group B: - 0.525% Sodium hypochlorite solution for 10 minutes.
3) Group C: - 5% Phenol solution for 10 minutes.
4) Group D: - 1.75% Iodophor solution for 10 minutes.

Culture and sensitivity test: All the samples from cotton swabs were taken on a sterile glass petridish and incubated at 37^0 C for 24 hours and the resultant colonial growth was gram stained and observed under light microscope in 100 x magnification. The impressions showing bacterial growth were considered infective whereas others were considered sterile **(Figure 9, 10 and 11).**

Dimensional accuracy: All 40 casts' measurements were recorded by one operator using a Digimatic verneer caliper. To establish reproducibility of measurements, three readings were taken for each cross – arch distance i.e. 3 readings for each model.

STATISTICAL ANALYSIS

The mean of three cross – arch measurements taken from the Gypsum stone casts were compared to those recorded from typhodont model and complete data was fed into computer using the statistical analysis software SPSS 7.5. Thus purified files containing raw data were obtained for computerized statistical analysis (ANOVA - One Way Analysis).

RESULTS

The entire study was conducted in two phases and both were undertaken as in vitro.

PHASE 1: ANTIMICROBIAL EFFICACY OF DISINFECTION PROCEDURES

When painted/infected impression disinfected with 0.525% Sodium hypochlorite, 2% glutaraldehyde, 5% Phenolic compound and 1.75% iodophor were swabbed and cultured showed absence of microbial growth against Staphylococcus aureus, Streptococcus mutans and Candida Albicans, thus indicates disinfection of infected impression.

PHASE 2: DIMENSIONAL ACCURACY

Digimatic vernier caliper was used to measure the cross-arch distance in the master model, and was recorded as 49.9 mm. The three measurements and the mean distance of their respective casts were made when impressions were immersed in 0.525% sodium hypochlorite, 2% glutaraldehyde, 5% phenol and 1.75% Iodophor.

TABLE I shows the mean cross-arch distance, variance and standard deviation of all the casts obtained from impressions dipped in the disinfected solutions. The least mean cross-arch distance was found in 2% glutaraldehyde (50.115), whereas the maximum was of 0.525% sodium hypochlorite. This showed that there was least dimensional change in the casts when disinfected with 2% glutaraldehyde and most when immersed in 0.525% sodium hypochlorite. The TABLE also showed that there was least variance for 5% Phenol solution whereas highest for the 0.525% sodium hypochlorite solution.

TABLE II shows the analysis of variance test values. The F-ratio = 14.1815, is the ratio of the between-group estimate to the within-group estimate and the p-value calculated was 0.0001. Since the p-value of the F-test is less than 0.05, there is statistically significant difference between the mean cross-arch distance from one level disinfected casts to another by a value of 0.221500.

GRAPH I shows the comparison of mean distance between the master model and the different disinfected casts. The mean cross-arch distance of casts obtained after immersion of immersion in glutaraldehyde, Iodophor, Phenolic compound and sodium hypochlorite were 50.115, 50.245, 50.371 and 50.407 mm respectively.

Table I: **The mean readings, variance and standard deviation values of the cross arch measurements on casts obtained from disinfected impressions**

	MEAN READING	VARIANCE	STANDARD DEVIATION
GROUP A	50.115 mm	0.00678333	0.082361
GROUP B	50.407 mm	0.2711567	0.164793
GROUP C	50.245 mm	0.00329444	0.0573973
GROUP D	50.371 mm	0.123878	0.1113

Table II: table for the analysis of variance (ANOVA).

SOURCE	SUM OF SQUARES	Df	MEAN SQUARE	F- RATIO	P – VALUE	CRITICAL VARIATION
BETWEEN GROUPS	0.52779	3	0.17593	14.18	0.0001 (<0.05)	0.221500
WITHIN GROUPS	0.4466	39	0.124056			
TOTAL	0.97439	39				

F – Ratio: Ratio of between group estimate to within group estimate

P = 0.001 (<0.05): There is statistically significant difference between the mean from one impression to another at 95% confidence level.

Graph I: comparison of mean distance between the master model and the different disinfected casts

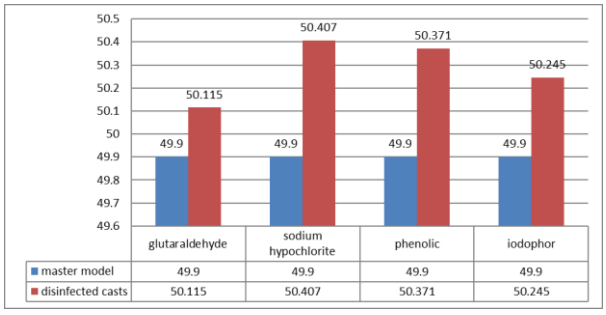

Fig 1: Disinfectants used: Glutaraldehyde (2%), phenolic compound (5%), iodophor (1.75%), sodium hypochlorite (0.525%).

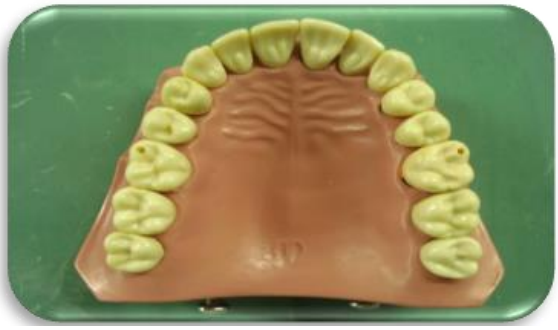

Fig 2: Brtish columbia typhodont with holes on Mesio buccal cusp of 16 and 26.

Fig 3: Impression material (Neocolloid) and Gypsum product Type III.

Fig 4: Bacterial colonies, glass petridish, disposable sterile swab, and sterile loop.

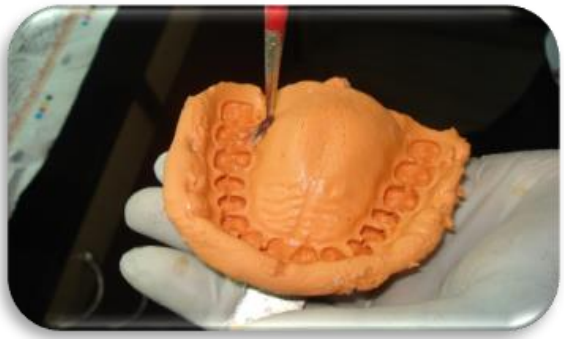

Fig 5: Painting of impression with bacterial colonies.

Fig 6: Wiping of cotton sterile swab over infected impression.

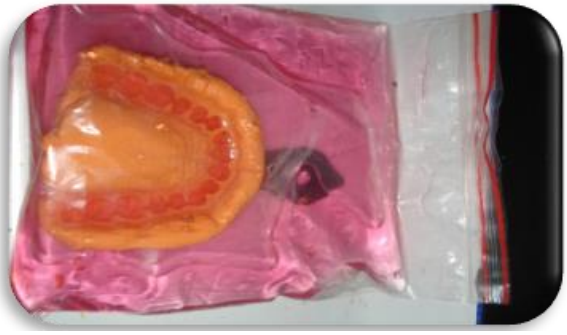

Fig 7: Impression immersed in 5% phenol in a sealed plastic bag.

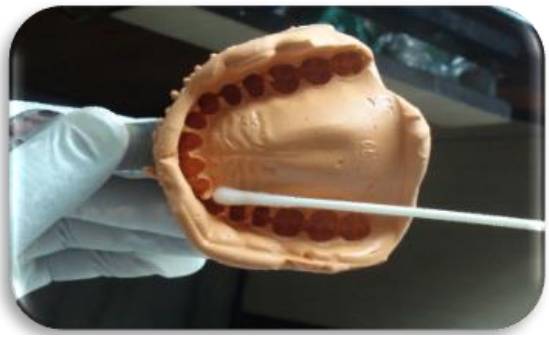

Fig 8: Disinfected impression wiped by sterile cotton swab.

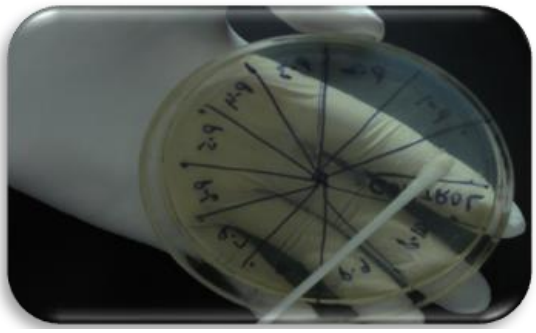

Fig 9: Wiping of swabs on the glass petridish.

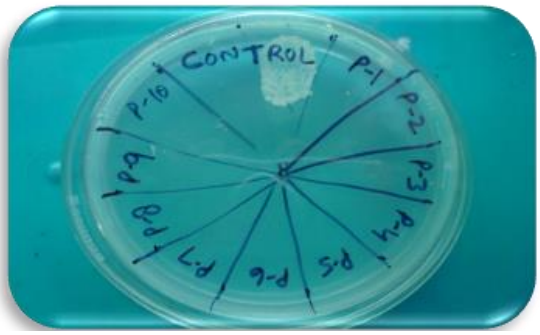

Fig 10: Glass petrish showing colonial growth in control group only.

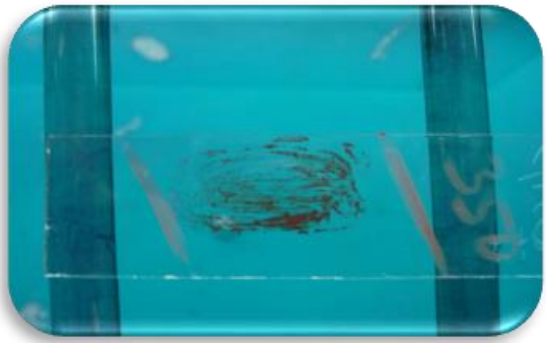

Fig 11; Gram stained bacterial colonies on glass slide.

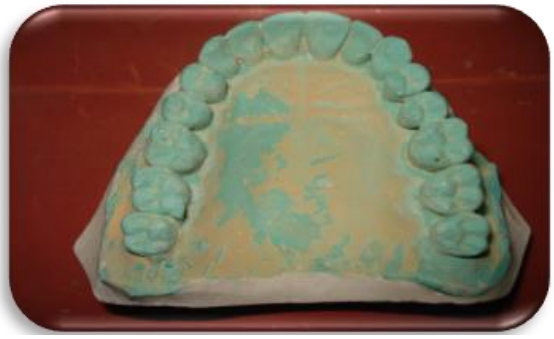

Fig 12: Surface detoriation of cast obtained by disinfecting impression by 0.525% sodium hypochlorite.

DISCUSSION

Infection control has become an important issue for the dental laboratory personnel in recent years. Dental impressions become contaminated with micro-organisms from patient's saliva and blood which can cross infect stone casts poured against them. This study was designed to evaluate the antimicrobial efficacy of four commercially available disinfectants and their resultant effect on the dimensional accuracy of the cast poured after irreversible hydrocolloid impression material was immersed for 10 minutes. The result indicated a clear reduction in the bacterial colonies when compared with the control group.

Clinical Implication:

This in–vitro investigation demonstrated that irreversible hydrocolloids immersed in disinfectants for 10 minutes exhibit antimicrobial activity. Because it is not possible to extrapolate the in – vitro study situation to clinical environment further study was needed to develop a more realistic disinfection technique to demonstrate the true antimicrobial efficacy of the disinfectants.

Casts made following immersion in 0.525% Sodium Hypochlorite showed poor surface quality **(Figure 12).** Visual perception of these impressions prior to pouring of casts showed loss of surface details. Acceptable method of measuring the dimensional accuracy of casts includes measuring microscopes, micrometers, dial gauges and Digimatic vernier callipers. The latter was used in this study with good reproducibility between the repeat readings of each cross–arch measurements.

It was expected that exposure of the impression material to disinfectants would adversely affect the dimensional accuracy due to imbibition. However, the results didn't showed such. This may be due to initial syneresis (causing contraction of the impression material) counteracted by imbibition during disinfection and / or by linear expansion of setting model material counteracting imbibition thus creating a more accurate model. Further a laboratory work would be required to verify this theory. The largest deviation in measurement between the master model and casts made from disinfected impressions was 0.73 mm. This level of deviation would have a greater significance if the impressions were used to construct fixed partial prostheses. The mean percentage deviation of measurements recorded for gypsum casts poured after disinfecting by four different disinfectants produced comparable results. There was statistically significant difference ($p < 0.05$) in dimensional accuracy for the control group of the impression materials compared with the materials treated with disinfectant solutions [critical variation (C.V) = 0.221500] clinically insignificant amount of dimensional change was recorded. The results in this study compared favourably with other publications[17], although some studies have shown some dimensional changes following the disinfection of impressions using sodium hypochlorite. This may be due to the use of different brands of irreversible hydrocolloid impression material which hampers the comparison and emphasizes the need for compatibility studies to ensure that the most appropriate protocol is used for a given impression material. Clearly a universal protocol is not suitable given the range of materials available. This study was limited to immersion disinfection method only, not involving any other disinfection procedure like spraying technique or U.V rays. Also the material used was only alginate impression material and no other impression material was used and also didn't include viruses, and many other microorganisms present in the human flora.

CONCLUSION

From the foregoing study following conclusion and suggestions have been made: All the four disinfectants were effective against the selected bacterial species viz. Candida albicans,

Streptococcus mutans, Staphylococcus aureus. Casts obtained from disinfected impressions showed significantly good dimensional accuracy compared to the master model. Partial deterioration of Neocolloid was found following immersion in 0.525% sodium hypochlorite leading to poor surface quality of the resultant casts. Compatibility studies need to be performed in order to optimize the dimensional accuracy, anti-microbial efficacy and surface quality of the impression material following disinfection.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

1. Anusavice KJ Phillips' Science of Dental Materials. 11th ed. Philadelphia : W B Saunders Company.

2. Powell GL, Runnels RD, Saxon BA, Whisehant BS. The presence and identification of organisms transmitted to dental laboratories. J Prosthet Dent. 1990;64: 235 – 237.

3. Merchant VA, Mc Neight MK, Ciborowski CJ, Molinari a. Preliminary investigation of a method of disinfection of dental impressions. J Am Dent Assoc 1984;52:877 – 879.

4. Tobias RS, Browne RM, Wilson CA. An in - vitro study of the antibacterial and antifungal properties of an irreversible hydrocolloid impression material impregnated with disinfectant. J Prosthet Dent 1989;62:601 – 605.

5. Herrera SP, Merchant VA. Dimensional stability of dental impressions after immersion disinfection. J Am Dent Assoc 1986;133:419 – 422.

6. Rowe HR, Forest JO. Dental impressions: The probability of contamination and a nethod of disinfection. Br Dent J 1978;145:184 – 185.

7. Mc Niell MRJ, Coulter WA, Hussey DL, Disinfection of irreversible hydrocolloid impressions – A comparative study. Int J Prosthodont 1992;5:563 – 567.

8. Anil S. Samaranayake LP, Krygier G. Infection control in dental practice. 1st ed. AITBS Publishers and Distributers; 1999 pg 91 – 102, 117 – 124.

9. Drennon DG, Johnson GH, Powell GL. The accuracy and efficacy of disinfection by spray atomization on elastomeric impressions. J Prosthet Dent 1989; 62: 468 – 475.

10. Rueggeberg FA, Beal FE, Kelly MT, Schuster GS. Sodium hypochlorite disinfection of irreversible hydrocolloid impression material. J Prosthet Dent 1992: 67: 628 -631.

11. White JM, Gibbin JM, Podesta R. Efficacy of disinfecting solutions and procedures on hydrocolloid impressions. J Dent Res 1990; 63: 701 – 707.

12. Look JO, Clay DJ, Crong K, Messer HM. Preliminary from disinfection of irreversible hydrocolloid impressions. J Prosthet Dent 1990; 63: 701 -707.

13. Minagi S, Yano N, Yoshida K, Tsuru H. Presentation of acquired immunodeficiency syndrome and hepatitis B. II: Disinfection method for hydrophilic impression material. J Prosthet Dent 1994; 71: 387 – 389.

14. Cserna A, Crist RL, Adams AB, Dunning DG. Irreversible hydrocolloids: a comparison of antimicrobial efficacy. J Prosthet Dent 1994; 71: 387 – 389.

15. Mansfield SM, White JM. Antimicrobial effects of incorporation of disinfectants into gypsum casts. J Dent Rest 1990; 69: 242.

16. Schutt RW. Bacterial effect of disinfected dental stone on irreversible hydrocolloid impressions after immersion in disinfectant solutions. J Prosthet Dent 1989; 69: 725 – 728.

17. Martin N, Martin MV, Jedynakiewicz NM. The dimensional stability of dental impression materials following immersion in disinfecting solutions, Dent Matter. 2007 Jun; 23(6): 760 – 768. Epub 2007 Mar 13.