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Effect of Disinfection with Hypochlorous Acid on Compatibility with impression materials of type III dental Stone

(i) Ann A.Nasser , (ii) Shorouq M. Abass
(i) Dentistry College, University of Baghdad, Iraq
(annakram039@gmail.com)
Orcid: https://orcid.org/0000-0002-2035-7600
(ii) Department, Dentistry College, University of Baghdad, Iraq
(shorouq.m.abass@codental.uobaghdad.edu.iq)
Orcid: http://orcid.org/0000-0002-2035-7600

Abstract

Background: In dentistry, dental stone are utilized to create casts for various dental laboratory procedures. Since it comes into contact with the saliva and blood observed on dental impressions, it is regarded as an origin of contamination. Disinfection of the cast has become crucial to preventing infections. **Aim:** To determine how type III dental stone's compatibility with the impression materials will be affected by adding a disinfectant (hypochlorous acid (HOCl)) as a water replacement. **Methods:** A total of 90 specimens of type III dental stone were prepared and separated into three groups, ten specimens for each test group, including group A (control), group B (incorporation of 60 ppm HOCl), and group C (incorporation of 100 ppm HOCl). There were 30 specimens for each type of impression material, including alginate, addition silicone, and zinc oxide eugenol. The specimens of compatibility with the impression material of type III dental stone were evaluated using an optical microscope (Dino-Lite, Taiwan). **Results:** The results presented that all specimens passed the compatibility with the impression materials test after adding HOCl, which received a score of I. **Conclusion:** Since type III gypsum products tested for compatibility with impression materials are unaffected by the addition of a hypochlorous acid disinfection solution, this is encouraging.

Keywords: dental stone, hypochlorous acid, compatibility with impression materials, Fourier Transmission Infrared Spectroscopy.

Introduction

The use of prosthetic rehabilitation has expanded as a result of the widespread usage of prosthetic devices to make up for congenital or acquired deficiencies (caused by disease or trauma), where surgical treatment may not always be possible due to the size and location of the defect (Naji et al., 2020).

Gypsum and its products have been utilized in numerous industries for a long time. It is mainly used in dentistry to create casts and perform several dental laboratory processes. Due to the multiple ways that infectious microorganisms can be transmitted from the patient's saliva to the castings, restorative dentistry provides a principally significant danger for cross-contamination with stone casts. Therefore, these casts must be disinfected after each clinical and laboratory treatment (Meghashri et al., 2014).

A dental professional's greatest danger is the risk of contracting and/or spreading life-threatening infectious diseases. It has been demonstrated that equipment supplies, instruments, impressions, and casts could be a source of microbial infection as they could make it easier for diseases to spread through saliva and blood. As a result, greater precautions must be taken when creating, manipulating, and developing prosthodontic restorations (Carr and Brown, 2011). From the viewpoint of a dental laboratory, it could be more effective to wash away the impressions before the stone pouring and then sterilize the cast to eliminate any visible contaminants, like blood and saliva (Moslehifard et al., 2012).

The American Dental Association (ADA) and the Centers for Disease Control and Prevention (CDC) advise disinfecting dental impressions or gypsum casts before using them. As impression disinfection is hard and related with numerous difficulties, cast disinfection is now regarded as a crucial step in developing uncontaminated models and a cross-contamination control method (Chidambaranathan and Balasubramanium, 2019). Disinfectant solutions must effectively eliminate germs without impairing the cast's or die's physical characteristics, such as gypsum's capacity to maintain its size (Goel et al., 2014) The quality of the impression material, the impression technique, and the impression tray all impact the accuracy of dental impressions, which is crucial for fabricating dental prostheses (Mohammed et al., 2018).

Dental casts can be disinfected by immersing them in or spraying them with a disinfectant, according to the American Dental Association (ADA) and the Centers for Disease Control and Prevention. Other techniques for disinfecting the casts involve incorporating chemicals into the gypsum while it is being mixed or utilizing a die stone that contains a disinfectant (Al-khafaji et al., 2013).

Incorporating a disinfectant directly into the calcium sulfate hemihydrate is required owing to the immersion technique's potential disadvantages, the challenge of entirely covering the cast with the spray disinfecting solution, and the inability to assume that every impression brought into the laboratory has been disinfected (Abass and Ibrahim, 2012).

According to a study by Abdelaziz et al. and Ivanoveski et al., most of the gypsum products evaluated showed a decrease in strength values, particularly those combined with povidone-iodine, glutaraldehyde, and sodium hypochlorite (Abdelaziz et al., 2002; Ivanovskiet al., 1995).

Hypochlorous acid, which destroys a wide range of bacteria and viruses, is present in all mammals. Through the activity of an enzyme known as respiratory burst nicotinamide adenine dinucleotide phosphate oxidase, neutrophils, eosinophils, mononuclear phagocytes, and B lymphocytes create hypochlorous acid in response to injury and infection. The strongest binding of hypochlorous acid to the unsaturated lipid membrane compromises the integrity of the cell. The pH range between 3 and 6 is where hypochlorous acid is most prevalent, and its antibacterial effects are strongest (Chopra et al., 2016). Hypochlorous acid is a very high-level disinfectant, according to the US Environmental Protection Agency and the Centers for Disease Control and Prevention, due to its extensive use worldwide. This uncomplicated chemical mixture has the ability to kill a wide variety of bacteria and viruses fast and efficiently (Mikaeel and Namuq, 2019).

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The null hypothesis was that there was no change in the compatibility with impression materials of type III dental stone after incorporating 60 ppm or 100 ppm hypochlorous acid.

Materials and Methods

Preparation of specimen

An electronic scale with an accuracy of 0.01 g was used to weigh stone powder, and a graduated cylinder with an accuracy of 0.5 mL was used to measure water. Manipulation of dental stone (Elite model, Zhermack, Italy) was performed following the manufacturer's recommendation at a W/P ratio of 0.30 (30 mL / 100 g), as well as hand mixing for 1 minute to achieve a workable and uniform mixture. According to the Revised ANSI/ADA Standard No. 25-2015, all mixing and testing of the dental gypsum materials were performed at a temperature (23±2) °C and a relative humidity (50 ± 10) %; in addition to all mixing and testing apparatus and instruments were dry, clean, and free of gypsum particles. Before testing, the dental stone and test apparatus were kept at the test temperature for a sufficient time (minimum storage period of about 15 hrs.) to equilibrate with the abovementioned condition.

Specimens grouping

A total of 90 specimens of type III dental stone (30 specimens of alginate and 30 specimens of zinc oxide eugenol, and 30 of addition silicone) and divided into three groups:

Group A → Dental stone tone powders were mixed with Distilled water

Group B→ Dental stone powders were mixed with 60 ppm HOCl.

Group C→ Dental stone powders were mixed with 100 ppm HOCl.

Compatibility with the impression materials test

Specifically designed testing equipment (a test block, a ring mold, and a slit mold) were used for this test, The test followed the Revised ANSI/ADA Standards No. 19-2017. the "a" groove with a 20-µm width is significant for evaluating compatibility with impression materials for type III dental stone.

The equipment shown in (Figure 1) had the characteristics listed below.

1. The test block's upper surface has three horizontal grooves, labelled "a" "b" and "c" each measuring 50 µm, 20 µm, and 75 µm respectively, and spaced 2.5 mm apart. Two more vertical grooves are positioned perpendicularly to the previously described grooves, each with a V-shaped angle and a width of 75 µm.
2. A ring mold with a 6 mm height and an interior diameter of 30 mm for pouring impression materials into the grooved surface of the test block.
3. A slit mold with a 30 mm inner diameter and a 20 mm height for pouring dental stone against ring mold.

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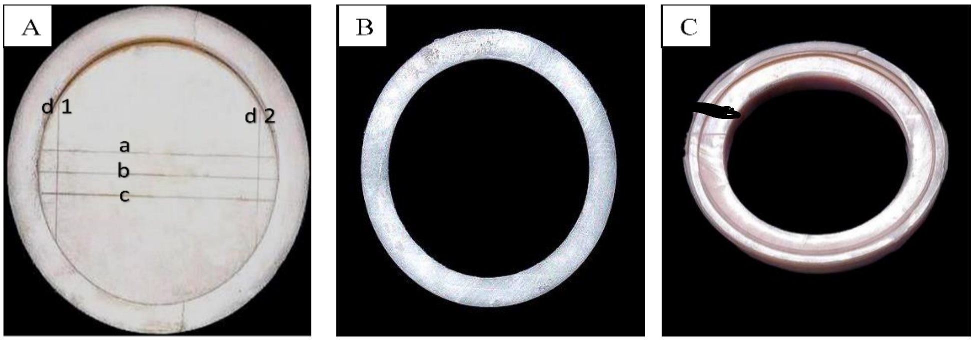

Figure 1: Test equipment utilized in compatibility test; A: test block; B: ring mold C: slit mold.

This test used three types of impression materials: alginate, addition silicon, and zinc-oxide eugenol as shown in Figure 2. The impression materials were used individually to replicate the test block's grooved surface. The impression materials were mixed according to the manufacturer's specifications and were poured into ring mold until slightly overfilled. The glass plate was placed over the mold, and a 1500 g load was applied for 5±1 seconds then, the load was removed, and the material was allowed to set.. The dental stone was mixed; then, the mixture was poured while slightly vibrating the slit mold for 30 seconds to avoid entrapment of air bubbles until the mold was filled.

Figure 2: (A) Alginate; (B) Zinc oxide eugenol impression materials; (C) Addition silicone (light and heavy bodies)

Specimens of dental stones were separated and assessed using an optical microscope (Dino-Lite, Taiwan) positioned at a preset distance with a 4X magnification. According to World Health Organization (WHO), the evaluation was carried out by two dentists who observed and assessed the testing specimens (WHO, 2013).

The following criteria were set up to assess the 20 µm line, which got the subsequent score: (Jasim and Abass, 2022)

Score I: Sharp and continuous line through the entire ring's width;
score II: Sharp and continuous line through more than half of the ring's width;
score III: Sharp and continuous line through only a part of the ring's width;
score IV: The line fails to be replicated along the ring's width.

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Fourier Transmission Infrared Spectroscopy (FTIR)

Identifying functional groups and investigating potential connections were done using Fourier transmission infrared spectroscopy (FTIR). At room temperature, FTIR patterns were identified for the predetermined samples. To achieve this, 0.5 micrograms of the prepared samples were placed in the FTIR device's pan (TWO Perkin Elmer, USA), which was set to wavelengths between 400 and 4000 (cm^{-1}).

Results

Compatibility with the impression materials

The findings of this test showed that all specimens from the control group and the experimental group (60 ppm and 100 ppm HOCl) had passed the test by reproducing a complete 20-µm-wide "b" groove and had a score I, as shown in (Figures 3, 4, and 5).

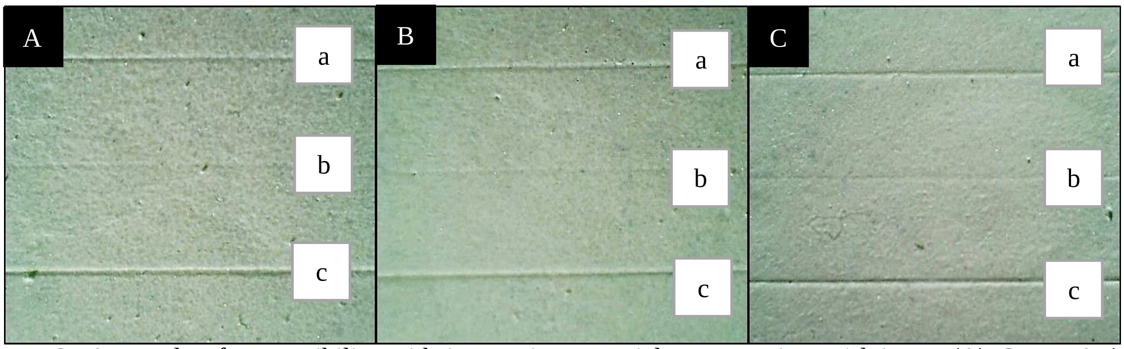

Figure 3: A sample of compatibility with impression materials test specimens/alginate; (A) Group A (control); (B) Group B (60 ppm HOCl); (C) Group C (100 ppm HOCl)

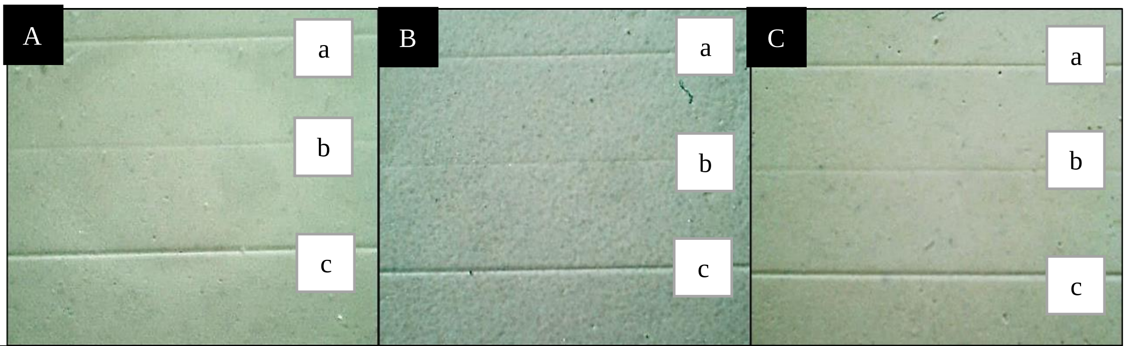

Figure 4: A sample of compatibility with impression materials test specimens /zinc oxide eugenol; (A) Group A (control); (B) Group B (60 ppm HOCl); (C) Group C (100 ppm HOCl)

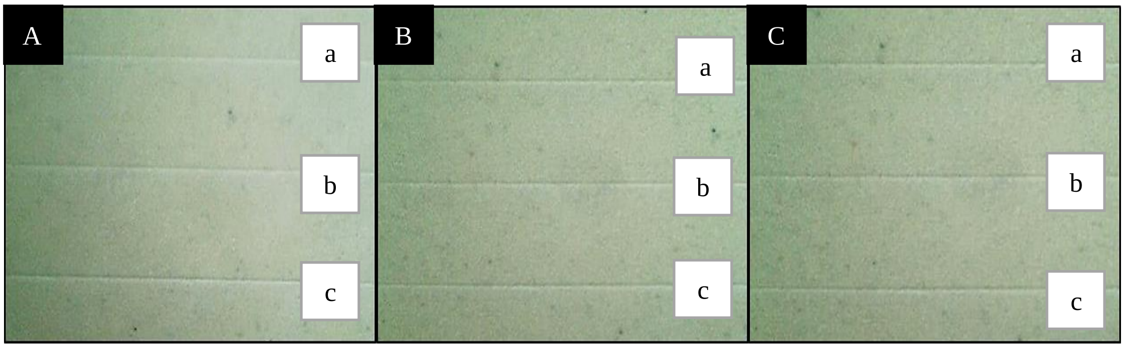

Figure 5: A sample of compatibility with impression materials test specimens/addition silicone; (A) Group A (control); (B) Group B (60 ppm HOCl); (C) Group C (100 ppm HOCl)

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Fourier transform infrared (FTIR) spectroscopy

The result of this test revealed no difference in the spectra between the control specimen (type III dental stone) and the experimental specimens (type III dental stone-HOCl) since there was no change in the pattern and the alignment of the absorption peaks; this means that there was no new chemical compound formation or change in the chemical structure of the material as shown in (Figure 6).

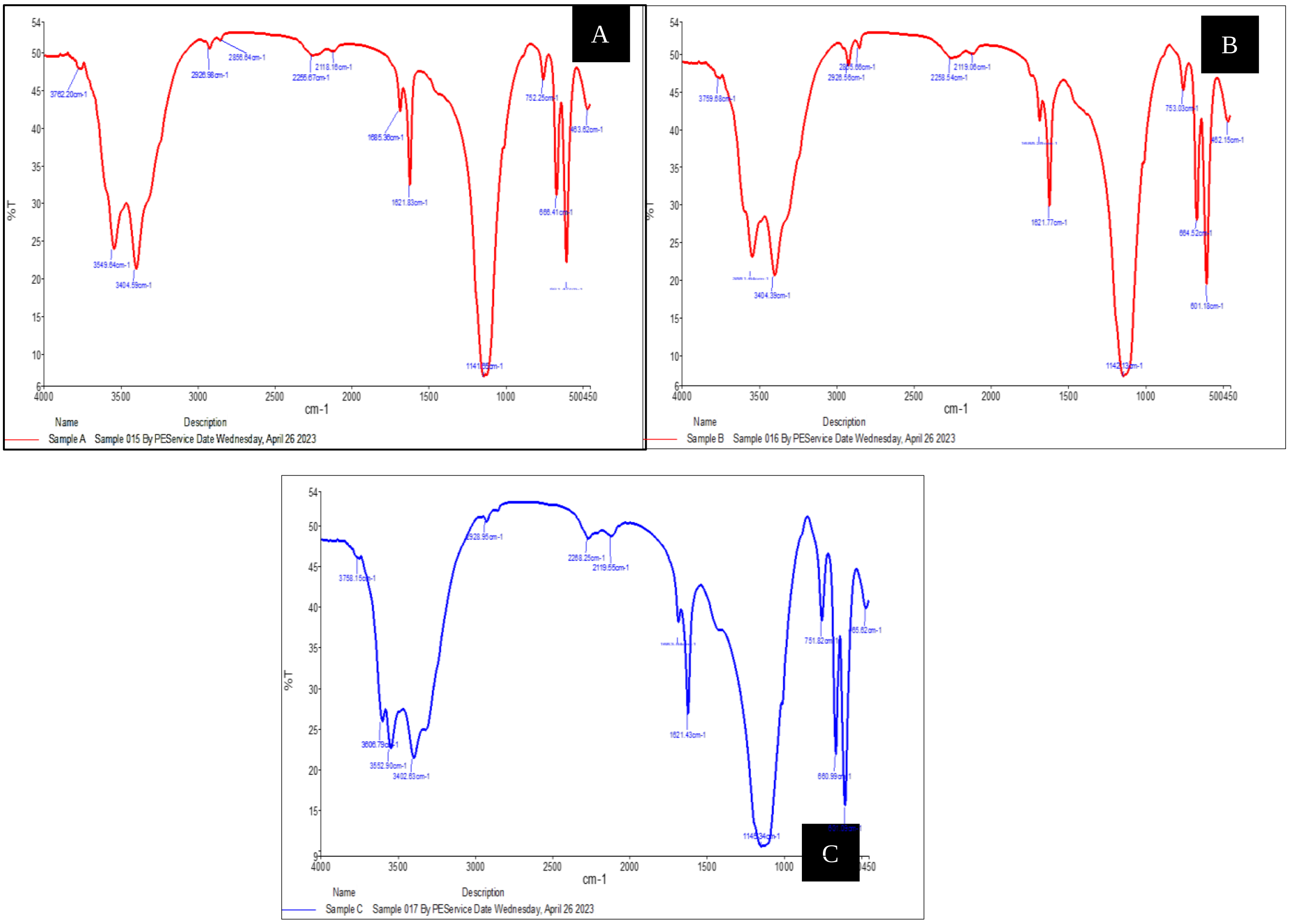

Figure 6: FTIR spectrum of (A) Group A (control); (B) Group B (60 ppm HOCl); (C) Group C (100 ppm HOCl)

Discussion

Every dental professional has a responsibility to conduct their job in a way that limits the threat of infection and cross-contamination. It is crucial to safeguard dental staff and patients from cross-contamination by employing suitable disinfection procedures in conjunction with the COVID-19 pandemic and the increase in frequency and prevalence of infectious diseases, including HIV/AIDS and hepatitis B and C (Patil et al., 2020).

Since mouth impressions typically contain microorganisms from the patient's blood and saliva, stone molds can be readily contaminated by them. Recent research findings have shown that set gypsum allows oral microorganisms to persist for up to seven days (Kumar, 2021).

CDC (2008) and ADA (1996) advise dental offices to use infection prevention methods. Dental impressions and casts are now routinely sterilized as part of healthcare systems. However,

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all sterilization techniques are ineffective for these materials due to the potential for adverse effects and loss of dimensional accuracy (ADA, 1996; CDC, 2008).

The ADA recommends immersing in an appropriate disinfectant or spraying with an appropriate disinfectant solution for disinfecting dental casts. Additionally, some authors have suggested using disinfectants instead of water when mixing gypsum (Roy et al.,2010).

The US Environmental Protection Agency has advised several disinfectants against COVID-19, including HOCl (US Environmental Protection Agency,2020).

HOCl is the most efficient chemical against germs, and it is completely harmless because it is natural, chemical-free, and non-toxic (Rahman et al., 2016).

The results of compatibility with impression materials revealed that the incorporation of both 60 ppm and 100 ppm HOCl in the mixing water of dental stone resulted in no change regarding the compatibility with impression materials quality in comparison to the control group; in other words, all the specimens of both the control group and the experimental groups (60 ppm and 100 ppm HOCl) had fulfilled the test requirement of 20 µm-wide "b" groove reproduction. This finding agrees with Abdelaziz et al., who approved those chemical disinfectants added to gypsum material have less influence on its wet-ability and, as a result, on the compatibility of impression materials (Abdelaziz et al., 2005). Such a finding can be related to the quick, precise, and careful manipulation that involved applying dental stone mixture incrementally into the slit mold while being vibrated to reduce air bubble trapping and assure the highest likelihood for the grooved surface to be copied accurately, particularly the 20 µm-wide "b" groove, in addition to the relatively small specimens' size (20 mm high and 30 mm in diameter).

Conclusion

Hypochlorous acid concentrations of 60 ppm and 100 ppm were found to be promising within the parameters of the study as an efficient disinfection that wouldn't affect the compatibility with the impression materials of type III dental stone.

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conflict of Interest

The author declared that they have no conflict of interest.

References

1. Abass, S.M. and Ibrahim, I.K. (2012). The effect of addition of calcium hypochlorite disinfectant on some physical and mechanical properties of dental stone. *Journal of Baghdad College of Dentistry*, 24(1), pp. 36-43.
2. Abdelaziz, K.M., Combe, E.C. and Hodges, J.S. (2002). The effect of disinfectants on the properties of dental gypsum: 1. Mechanical properties. *Journal of Prosthodontics*, 11(3), pp.161-167. https://doi.org/10.1053/jopr.2002.126860
3. Abdelaziz, K.M., Combe, E.C. and Hodges, J.S. (2005). The Wetting of Surface-Treated Silicone Impression Materials by Gypsum Mixes Containing Disinfectants and Modifiers. *Journal of Prosthodontics*, 14(2), pp.104–109. https://doi.org/10.1111/j.1532-849X.2005.00019.x
4. Al-khafaji, A.M., Abass, S.M. and Khalaf, B.S. (2013). The effect of SOLO and sodium hypochlorite disinfectant on some properties of different types of dental stone. *Journal of Baghdad College of Dentistry*, 25(2), pp. 8-17.

5. ADA (1996). Infection Control Recommendations for the Dental Office and the Dental Laboratory. *The Journal of the American Dental Association*, 127(5), pp.672–680.doi:10.14219/jada.archive.1996.0280.

6. Carr, A.B. and Brown, D.T. (2011). *McCracken's Removable partial prosthodontics*. 12th ed. St. Louis, Missouri: Elsevier Mosby.
7. Center for Disease Control and Prevention (2008). MMWR 2008;52(No. RR-17): *Guidelines for disinfection and sterilization in health-care facilities*, 2008. Atlanta: CDC.
8. Chidambaranathan, A.S. and Balasubramanium, M. (2019). Comprehensive review and comparison of the disinfection techniques currently available in the literature. *Journal of Prosthodontics*, 28(2), pp.e849-e856. https://doi.org/10.1111/jopr.12597
9. Goel, K., Gupta, R., Solanki, J. and Nayak, M. (2014). A comparative study between microwave irradiation and sodium hypochlorite chemical disinfection: a prosthodontic view. *Journal of Clinical and Diagnostic Research*: JCDR, 8(4), p.ZC42. doi: 10.7860/JCDR/2014/8578.4274
10. Ivanovski, S., Savage, N.W., Brockhurst, P.J. and Bird, P.S. (1995). Disinfection of dental stone casts: antimicrobial effects and physical property alterations. *Dental Materials*, 11(1), pp.19-23. https://doi.org/10.1016/0109-5641(95)80004-2
11. Jasim, Z.M., Abass, S.M., Jasim, Z.M.A. and Abass, S.M. (2022). The Effect of Hypochlorous Acid Disinfectant on the Reproduction of Details and Surface Hardness of Type III Dental Stone. *Cureus*, 14(11). DOI: 10.7759/cureus.32061
12. Kameda, T., Oka, S., Igawa, J.I., Sakamoto, M. and Terada, K., 2022. Can hypochlorous acid be a powerful sanitizer to replace alcohol for disinfection?—Its bactericidal, degradation of the solutions under various storage condition, and steel rust effects. *Dental Materials Journal*, 41(1), pp.167-183.
13. Kumar, P. (2021). Evaluation of Cymbopogon Citratus as Disinfectant and its Effect on the Dimensional Stability of the Resultant Gypsum Casts: An in Vitro Study. *UNIVERSITY JOURNAL OF DENTAL SCIENCES*, 7(3). DOI: https://doi.org/10.21276/ujds.2021.7.3.5
14. Meghashri, K., Kumar, P., Prasad, D.K. and Hegde, R.(2014). Evaluation and comparison of high-level microwave oven disinfection with chemical disinfection of dental gypsum casts. *Journal of International Oral Health*: JIOH, 6(3), p.56. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4109246/
15. Mikaeel, J.M. and Namuq, M.K., 2019. Evaluation of some properties of elastomeric dental impression materials after disinfection. *Erbil Dental Journal* (EDJ), 2(1), pp.187-196.
16. Mohammed, D.H., Fatalla, A.A. and Jani, G.H. (2018). Comparison of Some Mechanical and Physical Properties of three Types of Impression Materials with Different Dental Implant Angulations. *Biomedical and Pharmacology Journal*, 11(3), pp.1359-1368. DOI : https://dx.doi.org/10.13005/bpj/1499
17. Mohammed, M.J. and Abass, S.M. (2023). Influence of Hypochlorous acid on Surface Roughness and Wettability of Addition Silicon Impression Material. *The Egyptian Journal of Hospital Medicine*, 90(2), pp.3630-3635. DOI:10.26655/JMCHEMSCI.2023.5.1
18. Moslehifard, E., Nasirpouri, F., Mahboub, F., Salehjou, M., Ghasemzadeh, S. and Bahari, M. (2012). Influence of chemical disinfection on mechanical and structural properties of type III and IV dental stones. *Advances in Applied Ceramics*, 111(8), pp.450-458. https://doi.org/10.1179/1743676112Y.0000000003
19. Naji, G.A.H., Ali, M.M. and Farhan, F.A (2020). Physico-Mechanical Behavior of Room Temperature Vulcanized Maxillofacial Silicon after Addition of Glass Flakes. *Indian Journal of Forensic Medicine & Toxicology*, 14(1), pp.1304-1310. DOI : 10.37506/v14/i1/2020/ijfmt/193090
20. Patil, S., Mukhit Kazi, M., Shidhore, A., More, P. and Mohite, M. (2020). Compliance of sterilization and disinfection protocols in dental practice-A review to reconsider basics. *Int J Recent Sci Res*, 4(11), pp.38050-38054. DOI: http://dx.doi.org/10.24327/ijrsr.2020.1104.5232
21. Rahman, S.M.E., Khan, I. and Oh, D.H., 2016. Electrolyzed water as a novel sanitizer in the food industry: current trends and future perspectives. *Comprehensive Reviews in Food Science and Food Safety*, 15(3), pp.471-490. https://doi.org/10.1111/1541-4337.12200
22. Roy, S.M., Sridevi, J. and Kalavathy, N., 2010. An evaluation of the mechanical properties of Type III and Type IV gypsum mixed with two disinfectant solutions. *Indian Journal of Dental Research*, 21(3),

p.374. https://www.ijdr.in/article.asp?issn=0970-9290;year=2010;volume=21;issue=3;spage=374;epage=379;aulast=Roy

23. US Environmental Protection Agency (2020) List N: Disinfectants for use againstSARS-CoV-2. Available at: https://www.epa.gov/coronavirus/list-n-advanced-search-page- disinfectants-coronavirus-covid-19.
24. World Health Organization, 2013. *Oral health surveys: basic methods*. World Health Organization.