RESEARCH ARTICLE

Evaluation of effect of incorporating 0.5% Chloramine-T as disinfectant in type III gypsum product on its setting time and abrasion resistance [version 1; peer review: awaiting peer review]

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Abstract

Background: Laboratory bacterial cross-contamination is very high in dentistry, to avoid this disinfection is a necessity. Gypsum products are a medium of cross infection between the dentist and the laboratory personnel. The purpose of this study was to determine, if Chloramine-T is added as a disinfectant in the gypsum type III material, then are there any changes in the setting time and abrasion resistance of the gypsum.

Methods: For setting time vicat needle apparatus (Brand- AIMIL Ltd.) was used for two groups one with Chloramine-T (Group-1) and one without Chloramine-T (Group-2) as disinfectant. For abrasion resistance a two body wear test was used, testing was done in two groups one with Chloramine-T (group-3) and one without Chloramine-T (Group-4) as disinfectant. For both the tests, each group had 35 samples. Pre weight and post weight of the samples were recorded for both control and experimental groups to measure abrasion resistance. For setting time the initial setting time was recorded for both the groups.

Results: It was discovered that the mean value calculated for setting time was 0.08 seconds more than the control group which is significant statistical value but this difference does not make a significant change while clinically manipulating gypsum as the initial setting time is 4-6 minutes. Also the difference in the mean value was not found as statistically significant for abrasion resistance of type III gypsum product before adding Chloramine-T between the control and experimental group.

Conclusions: The physical features of dental stone are unaltered with
the addition of Chloramine-T as a disinfected for type III gypsum product and hence it can be utilised for all of its dental applications. Gypsum product added with Chloramine-T as a disinfectant will prevent cross-contamination from occurring and help in maintaining the sanitisation.

**Keywords**
Disinfection, Chloramine-T, Gypsum products
Introduction
The importance of infection control in dentistry is growing to be crucial, leading to the creation of novel products and procedures to prevent patient-dentist cross-contamination.

The dentist and dental auxiliaries involved in the dental treatment are frequently exposed to a large variety of infectious pathogens including many fatal ailments like Hepatitis-B, HIV, COVID-19, etc. The development of Infection control guidelines by the American Dental Association (ADA) was established because of the potential threat caused from the virus and microbes in blood and saliva of a patient to the dentist and technician. They advised that all the involved personnel should wear necessary personal protective equipment like gloves, mask, protective eyewear, headcap and disposable barriers like gowns. These are recommended to ensure successful protection enveloping the patients and the doctors themselves from the transmissible dangers.

To break the chain of cross-infection, researchers have suggested disinfection of dental impressions being made. Various protocols have been proposed which include either spraying or immersion of the impression in some sort of disinfectant, but these techniques have a range of negative and positive implications on the impression. Nevertheless, it has been recommended that the impressions should be disinfected using a trusted and proven disinfection method. Once the impression is made it is disinfected, but the cast poured with gypsum product of the impression comes in repeated contact with the oral tissue during treatment of complete denture patients, due to the multiple appointments required with the treatment. Numerous types of research and surveys like those conducted by Yadav BK et al., suggest and report a significant discrepancy between the knowledge and application of such disinfection techniques by clinicians and technicians everywhere.

The work of Leung and Schonefield and Mitchell et al. have proven gypsum casts to be a potential source of infection. Thus, it is an imperative measure to disinfect these casts to inhibit progression of any kind of pathogen between the clinician, technician and the patient. Dental casts can be disinfected using two distinct methods. The first is surface disinfection, which can be accomplished with the help of spraying the disinfectant or dipping the cast in a disinfectant solution. The second method is to incorporate a disinfecting agent in the gypsum product being used. Addition of this agent can be done: in powder form within the gypsum powder, or in the water which will be used to mix the gypsum, or it can be added by replacing the water with the disinfectant or adding disinfectant to the water.

We cannot overlook the fact here that addition of any component to gypsum product might change its properties affecting its usability and application. Every disinfection method, in addition to providing an effective infection control, must also maintain the inherent characteristics of the material to be disinfected, providing, in the case of gypsum models, an acceptable texture, handling characteristics without changes, and adequate resistance. Therefore, it is necessary to assess how different disinfection techniques affect some of the physical and also some of the mechanical properties of gypsum models. In addition to this, all these above mentioned techniques necessitate an additional step in the already established practice which makes it all the more difficult to adapt to and inculcate in the regular dental treatment procedure.

Aim
Evaluation of the effect of incorporating 0.5% Chloramine-T as disinfectant in type III gypsum product on its setting time and abrasion resistance.

Objectives
1. To evaluate the effect of Chloramine-T on setting time of type III gypsum product.
2. To evaluate the effect of Chloramine-T on abrasion resistance of type III gypsum product.
3. To compare the mentioned properties with control group of type III gypsum product without Chloramine-T.

Methods
This prospective study was conducted at “Department of Prosthodontics, Crown & Bridge, of Sharad Pawar Dental College & Hospital”, DMIMER (Deemed to be University). Authorisation for the research was attained from the Institutional Ethics Committee.

Ref no.: - DMIMS (DU)/IEC/2020-21/9391

Study design: Comparative analytical Study
Duration: 2 years

Sample size: 140 (35 per group) (Figure 1)

Formula to calculate the sample size:

The formula and the $\alpha$ and $\beta$ value was taken from the article by Zhong B. published in the Journal of thoracic disease in 2009.15

$$k = \frac{n_2}{n_1} = 1$$

$$n_1 = \frac{(\sigma_1^2 + \sigma_2^2 / K) \left( z_{1-\alpha} + z_{1-\beta} \right)^2}{\Delta^2}$$

$$n_1 = \frac{(0.85^2 + 0.85^2 / 1)(1.96 + 1.64)^2}{0.73^2}$$

$$n_1 = 35$$

$$n_2 = Kn_1 = 35$$

Where:

$\Delta = |\mu_2 - \mu_1|$ = absolute difference between two means

$\sigma_1, \sigma_2$ = variance of mean #1 and #2

$n_1$ = sample size for group #1

$n_2$ = sample size for group #2

$\alpha$ = probability of type I error (usually 0.05)

$\beta$ = probability of type II error (usually 0.2)

$z$ = critical Z value for a given #2 to group #1

$k$ = ratio of sample size for group #2 to group #1
Material (Figure 2):

- Type III gypsum product (Kalstone, Kalabhai Karson Pvt Ltd, Article no. 211003)
- Chloramine T powder (Sigma Aldrich, CAS Number: 7080-50-4, Molecular weight: 281.69, PCode: 102050513)
- Petroleum jelly (KIM Chemicals Ltd, Batch no. 90, Drug Licence no.: KD-260)
- Distilled water

Instruments (Figures 3 and 4):

- Rubber bowl and plaster spatula (EiTi Rubber Mixing Bowls, Dental cart and Dental plaster spatula, Dental cart)
- Measuring cylinder (STAR LABS plastic measuring cylinder)
- Mould for sample fabrication for testing abrasion resistance (Casting of mould done in Nagpur Engineering Works- Metal Fabricator)

Equipment (Figures 5-7):

- Two body wear test apparatus (Designed by Praj Laboratory, Pune, Maharashtra, India)
- Vicat needle apparatus (AIMIL Ltd. with ISI Certification mark, IS: 5513, AIM:394)
- Digital weighing machine (AIWA Digital electronic weighing machine)
- Vacuum mixer (Aixin- AX 2000C Vacuum mixer, Technical Data: Mixing Speed: 1~550rpm (Stepless speeds), Mixing Beaker: 550ml,750ml, Vacuum: 0.08~0.09MPa, Built-in Vibrator)
- Dental vibrator (Dental vibrator AX-Z3 Dental Vibrator Article Number MP02001 Certification ISO9001:2000)

![Figure 2. Material used in the study. A - Chloramine-T. B - Petroleum jelly. C - Dental stone.](image-url)
Figure 3. **Instruments used in the study.** A - Bowl. B - Spatula. C - Measuring cylinder.

Figure 4. **Mould for fabricating samples to test abrasion resistance.**

Figure 5. **Digital weighing machine.**
Abrasion resistance

Fabrication of mould

A three piece stainless rectangular stainless steel mould was fabricated with the help of sand casting. The lower part or the base of the mould was a stainless steel plate with a height of 5 mm. The middle part made with stainless steel, and was rectangular in shape and contained 10 circular disc shaped holes of size 15mm in diameter and 3mm in thickness (the middle plate was cast in the given dimension with the holes by sand casting of the mould). The upper part or the top of the mould was made with stainless steel, rectangular in shape and acted as a lid for the mould. All three parts were held

Figure 6. Vacuum mixer.

Figure 7. Dental vibrator.
together with help of two vertical rods, these were fabricated on the lower part of the mould with sand casting method. There were locking nuts over these rods which could be tightened together with help of a screw. All the parts of the mould were cast individually and then assembled (Figure 4).

Incorporation of Chloramine-T in gypsum for experimental group

50 mg Chloramine-T was weighed in the digital weighing machine (AIWA Digital electronic weighing machine) which was added to 100 grams of type III gypsum product. The gypsum product was mixed according to the manufacturer’s instruction (Kalstone, Kalabhai). Water/Power (Gypsum product type III) ratio used for mixing was 0.27, according to the ADA specification no.25 (Figure 8).

Preparation of the mould

Separating medium (Petroleum jelly, KIM Chemicals Ltd.) was applied to the mould for easy retrieval of the sample.

Fabrication of sample

For the control group, with the aid of a vacuum mixer (Aixin- AX 2000C Vacuum mixer) gypsum product of type III gypsum was mixed in the appropriate water/powder ratio provided by the manufacturer which was 0.27. The middle part of the mould was kept over the lower part of the mould in which then mixed gypsum product was dispensed. Dispensing of gypsum product type III (also known as dental stone) was carried out on a vibrator (Dental vibrator AX-Z3) to minimize entrapment of air. After gypsum product was adequately dispensed in the mould, where lower part and middle part was placed on a flat platform and gypsum product was poured in the holes of the middle part then the upper part of the mould was placed and screws were tightened. Gypsum product was allowed to set for 30 minutes and then sample was retrieved by firstly unscrewing the mould and removing the upper and the lower part of the mould followed by gently tapping the middle part of the mould.

For the experimental group, type III gypsum product was used admixed with 0.5% chloramine-T. Similar to the control group gypsum product was mixed with help of the vacuum mixer. The mix was poured in the mould with help of a vibrator. The same process used for fabrication of sample for control group (Figure 9).

Method for testing abrasion resistance

Two body wear test apparatus

This device is composed of a chisel that is fixed to a stand and abrades the sample while being perpendicular to it. Since abrasion happens when one hard surface is rubbed against another, it is often referred to as “two-body wear.” No extra abrasive material was utilized; instead, the chisel served as the sample’s abrading device in this instance. Stabilization of the chisel was achieved by applying weight of 50 grams over it. Before testing was done a pre-testing weight of the sample
was recorded on digital weighing machine. The fabricated sample was secured on the platform of the apparatus and the stylus was kept perpendicular to the sample. The reciprocating table was driven at 350 rpm for three minutes and the sample was abraded. Post-testing weight was recorded after cleaning of the sample and all the abraded particles were removed. The difference of pre-test weight and post-test weight of the sample provided the amount of abrasion, this was done once for both group 3 and group 4 each with a sample size of 35. A comparison of control and experimental group was done to evaluate abrasion resistance of the respective samples (Figure 10).

**Figure 9.** Samples for testing abrasion resistance.

**Figure 10.** Testing abrasion resistance.

For setting time

Preparation of the material

50 mg Chloramine-T (Sigma Aldrich) was weighed in the digital weighing machine which was added to 100 grams of type III gypsum product. Gypsum product was mixed according to the water/powder ratio recommended by the manufacture (Kalstone, Kalabhai) which was 0.27. For the control group, use of a vacuum mixer was implemented to mix type III gypsum product. For the experimental group admix of type III gypsum product and 0.5% chloramine-T was used, mixing was done with a vacuum mixer. Preparation of the material was the same for both the tests.
Preparation of the mould

A stainless steel cylindrical mould with an interior diameter of 35 mm and a height of 50 mm was utilized. Petroleum jelly was applied to the mould for easy retrieval of the sample.

Method for testing setting time

The mixed gypsum product was poured into the metal Vicat apparatus' cylindrical mould, which measures 35 mm in height and 50 mm in internal diameter and smoothed out with a plaster spatula by placing it flat on the edge of the mould so as to evenly spread the gypsum product and remove any excess if present, to provide a flat surface on the top. This mould was placed in its position on the vicat needle apparatus, below the needle. Prior to setting of the gypsum product, the valve screw was turned lose enough for the needle tip to just contact the gypsum product's surface. The needle was then allowed to penetrate the mixture, and it was intended to extend all the way to the mould's base. Every 30 seconds, the entire procedure was repeated, with the mould being gently moved and the needle being cleaned each time. When the needle pierces the mix and degree indicated by the stylus tells us that the needle has reached the bottom of the mould or not, the valved screw was tightened each time. Until the needle could no longer pierce the mould all the way to the bottom, this process was repeated. Testing was done according to ADA specification no. 25 (Figure 11).

Statistical analysis

Descriptive and analytical statistics weas done. The data is presented as mean, median, and mean standard deviation. By using the Shapiro-Wilk test, the normality of continuous data was examined. Non-parametric tests were performed to analyse the data since the distribution of the data did not follow the normal distribution. The analysis made use of the Mann-Whitney U test and Wilcoxon signed-rank test. A non-parametric test Mann-Whitney U test is used to compare two sample means drawn from the same population and determine whether they are equal or not. A non-parametric statistical hypothesis test called the Wilcoxon signed-rank test is used to compare repeated measurements on a single sample to see whether their population mean ranks differ. When it is impossible to assume that the distribution of the difference between the means of two samples is normally distributed, it can be used as an alternative to the paired Student's t-test. The significance threshold was kept at p<0.05. SPSS (Statistical Package for Social Sciences) Version 24.0 (IBM Corporation, Chicago, USA,2016) (RRID:SCR_002865) has been used for all statistical analysis.

Figure 11. Testing setting time. A - Needle penetrating up to the base of mould. B - Needle not penetrating up to the base of the mould.
Chloramine-T’s effect on the type III gypsum product’s setting time was evaluated. It was discovered that there was statistically significant difference in mean setting time ($p = 0.004$) between control and experimental group. The mean setting time of the control group ($5.246 \pm 0.117$) was significantly lower than the experimental group ($5.322 \pm 0.094$) (Table 1).

Result for control group of abrasion resistance
Prior to addition of Chloramine-T, the abrasion resistance of type III gypsum product was assessed. It was found that there was no statistically significant change in the mean abrasion resistance ($p = 0.740$) of type III gypsum product between the control group’s pre and post weights before adding Chloramine-T. The mean abrasion resistance of control group pre weight ($1.0543 \pm 0.0049$) was almost similar to the post weight group ($1.0541 \pm 0.0048$) (Table 2).

Result for experimental group of abrasion resistance
Chloramine-T was added to Type III gypsum product, and its effect on abrasion resistance was evaluated. It was found that there was no statistically significant change in the mean abrasion resistance ($p = 0.740$) of type III gypsum product before adding Chloramine-T between experimental groups pre and post weights. The mean abrasion resistance of experimental groups pre weight ($1.0575 \pm 0.0771$) was almost similar to the post weight group ($1.0571 \pm 0.0772$) (Table 3).

Comparison of control and experimental groups of abrasion resistance
The type III gypsum products abrasion resistance before adding Chloramine-T was evaluated. It was discovered that there was no statistically significant difference in mean abrasion resistance ($p < 0.001$) of type III gypsum product before adding Chloramine-T between control and experimental group. The abrasion resistance mean value for control group post-test ($1.0541 \pm 0.0048$) was similar to experimental group post-test, after the addition of Chloramine-T ($1.0571 \pm 0.0772$). Hence, the abrasion resistance of both control and experimental group was almost similar (Table 4).

### Table 1. Evaluation of the effect of Chloramine-T on setting time (minutes) of type III gypsum product.

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>S.D.</th>
<th>Median</th>
<th>Z-value</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>35</td>
<td>5.246</td>
<td>0.117</td>
<td>5.240</td>
<td>-2.915</td>
<td>0.004†</td>
</tr>
<tr>
<td>Experimental</td>
<td>35</td>
<td>5.322</td>
<td>0.094</td>
<td>5.340</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*P-value derived from Mann-Whitney U Test.
†Significant at $p < 0.05$; N - number of samples; S.D. - Standard deviation.

### Table 2. Evaluation of abrasion resistance of type III gypsum product before adding Chloramine-T.

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>S.D.</th>
<th>Median</th>
<th>Z-value</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (Pre-test)</td>
<td>35</td>
<td>1.0543</td>
<td>0.0049</td>
<td>1.0550</td>
<td>-0.332</td>
<td>0.740</td>
</tr>
<tr>
<td>Control (Post-test)</td>
<td>35</td>
<td>1.0541</td>
<td>0.0048</td>
<td>1.0550</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*P-value derived from Mann-Whitney U Test; N - number of samples; S.D. - Standard deviation.

### Table 3. Evaluation of abrasion resistance of type III gypsum product after adding Chloramine-T.

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>S.D.</th>
<th>Median</th>
<th>Z-value</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental (Pre-test)</td>
<td>35</td>
<td>1.0575</td>
<td>0.0771</td>
<td>1.0450</td>
<td>-0.556</td>
<td>0.579</td>
</tr>
<tr>
<td>Experimental (Post-test)</td>
<td>35</td>
<td>1.0571</td>
<td>0.0772</td>
<td>1.0450</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*P-value derived from Mann-Whitney U Test; N - number of samples; S.D. - Standard deviation.
Discussion

The concept of cross-contamination in dental treatment is not a new introduction. From earlier eras, various scientists and researchers have emphasized its existence and the importance of its prevention.16 The plausibility of infection by the virtue of any dental procedure is quite high, making the patients, operators, technicians, and the operatory highly vulnerable to contracting any pathogenic or potential disease microbe. Researchers from time to time have shown and proven that the microbial flora of the oral cavity comprises innumerable opportunistic microorganisms which have the vigour to cause ailments of morbid conditions.17 This reason should be a motivating factor for every practicing clinician to attempt and contain cross-contamination to the best of their abilities. Under this scenario, the consolidation between a dental clinic and the prosthetic laboratory poses a tremendous emphasis on the entire policy of infection control. Countless patient-derived dental work is regularly conveyed between the clinic and laboratory placing both entities at high risk for the probability of microbial contraction.16 Studies performed by some investigators have proven the retrievability of microbial populations from dental casts separated from dental impressions were contaminated with pathogenic organisms.18 This could be an easily avoidable situation saving the health of all the involved parties if the infection control protocol were to be followed diligently. Thus, authorities and individuals felt a need for establishing an infection control protocol. Given this, guidelines pertaining to personal protective equipment, disinfection guidelines, etc. had been proposed and modified as per the requirements in the Guideline for Infection Prevention and Control, in the year 2021. The practical application of these guidelines are dependent on the dentist and the lab personnel while handling the used dental equipment, or the material required in the dental clinic or a laboratory.

Dental impressions or castings can be cleaned using a variety of technologies and protocols. Various research and surveys have reported and proven that a huge gap in the suggested and implemented disinfection protocol exists in the dental fraternity.20 Moreover, since these dental casts come in contact with contaminated dental equipment, or the material required in the dental clinic or a laboratory.

Dental stones fineness, setting expansion, compressive strength, setting time, and ability to replicate detail are all listed on their packaging. These physical characteristics are qualified for certification if they fall within predetermined parameters and the product is correctly packaged. Historically, compressive strength or hardness tests have been used to evaluate dental stone.21 Both of these qualities are indirect indicators of the stone’s resistance to the kind of scraping abrasion that is typical in the dental laboratory. Tests that mimic the characteristics of abrasion as it occurs in the dental laboratory have only recently been given thought. Abrasion resistance is tested in our study, as it is a crucial property of gypsum product required for fabrication of any dental prosthesis.

Products made from gypsum are crucial to dental treatment procedures.22 Understanding the behaviour and limitations of models, impression plaster, and gypsum bonded casting investments depends on the setting response. Gypsum in dentistry is used for a lot of purposes, like impression making, diagnostic cast or master cast fabrication, casting procedure, mounting cast on an articulator, processing for complete dentures, and many more. Various types of gypsum products are used for various applications. Type III gypsum product which was used in this study is used to fabricate a master cast which is required to be disinfected multiple times as in cases of complete denture.23 Material handling and use, as reflected in working and setting time, are controlled by the pace of setting reaction.

The mixing time is the amount of time that begins when the powder is added to the water and ends when the mixing is complete. Mechanical mixing typically takes 20 to 30 seconds to finish and for hand spatulation to produce a smooth
mixture, it usually takes at least a minute. The working time is the timespan from the start of the mixing process until the consistency becomes unsuitable for the product's intended usage. Before the gypsum solidifies, three minutes of working time should be sufficient to mix, pour a primary impression, and clean the equipment. As the reaction continues, the extra water on the surface is absorbed in the creation of the dihydrate, causing the mixture to lose its glossy surface and acquire strength. This is when the test for setting time is carried out.

Abrasion is when a material or structure like the skin or teeth is worn away by an uncommon or abnormal mechanical action. Abrasion testing is further classified into the two-body and three-body wear processes. When abrasive particles are tightly bound to the surface of the abrasive instrument and no additional abrasive particles are applied, two-body abrasion takes place. A tooth being ground down by a diamond bur is an illustration of two-body wear. When abrasive particles are allowed to freely translate and rotate between two surfaces, three-body abrasion takes place. The use of nonbonded abrasives, such as those found in dental prophylaxis pastes, is an example of three-body abrasion. In our study, a two-body wear test was carried out to evaluate the abrasion resistance of type III gypsum product.

The disinfectant chosen for this study is Chloramine T, also known as Tosylchloramide or N-chloro tosylamide, which is a well-reported industrial disinfectant that has multifaceted applications across a wide field array. It has been reported to be used in the treatment of foot and mouth disease, bacterial gill disease, disinfection of water, etc. In dentistry, chloramine T has been used as a storage medium for extracted teeth before they could be tested for any microbe-related examination. This has even been mentioned in the centre for infection control guidelines. Apart from this, chloramine T has also been used as an experimental addition to dentifrice to prevent biofilm formation over the complete dentures which will be polished. Chloramine T has also been used to successfully minimize biofilm formation on the titanium implant surface in independent experimental trials. A study conducted by Mushashe et al. evaluated the addition of 0.2% chloramine T to the temporary restorative agent and found that it did not affect the physical properties but also did not yield an optimum antimicrobial effect. The reason for this could be the low concentration of reagent used. Guiraldo et al. researched if disinfection of elastomeric impression materials with chloramine T affected its detail reproduction and dimensional stability and gave a positive conclusion and recommendation for its usage as a disinfecting agent. Thus, chloramine T was chosen as the choice of disinfectant for our study.

This study is a continuation of the study that was conducted in our institute in which the efficiency of 0.5% Chloramine-T as a disinfectant was evaluated and a few properties of gypsum like surface detail reproduction, dimensional accuracy, and compressive strength of type III gypsum product were evaluated.

Ivanovski et al. in 1995, explained how the povidone-iodine alters the stone cast's compressive strength and setting time, but not its expansion or ability to reproduce details. They add that the inclusion of chlorhexidine gluconate, povidone-iodine, and various concentrations of sodium hypochlorite solution did cause the setting time to lengthen, however the addition of glutaraldehyde to the stone combination had no effect on the setting time. Comparing this study to when in type III gypsum product chloramine-T is added the abrasion resistance is unaffected and changes shown in setting time does not have a clinical significance.

Breault LG et al. in 1998, compressive strength and rigidity of type V stone were found to increase and the setting time to decreased when 5.23% sodium hypochlorite solution was used in place of 10% gauging water. The fact that hemihydrate is more soluble due to the addition of sodium hypochlorite which works as an accelerator, this could account for the decrease in setting time, rise in compressive strength, as well as the increased rigidity. Decreased working time causes difficulty while the fabrication of the prosthesis to the laboratory technician. Setting time is mixing time in addition to the working time, as this study concludes that addition of sodium hypochlorite, decreases the setting time significantly and hence the working time of gypsum is also decreased. In the current study, setting time is increased by 0.08 seconds which is clinically not significant when compared to the study by Breault et al in which setting time is decreased.

Lucas et al. in 2008, confirmed that each disinfecting solution sodium hypochlorite 1%, glutaraldehyde 2%, chlorhexidine 2% promoted a relatively increased Vicat setting time at the evaluated concentrations; despite being statistically greater than the control group, the results obtained were within an acceptable range after the addition of chlorhexidine and glutaraldehyde.

Setting time was evaluated in our study, resulted in an increase of 0.08 seconds which is within the range of setting time of gypsum products provided by the ADA specification. Hence even if there was a statistical significance the change in setting time, it is not significant clinically. The increase of 0.08 seconds would not cause any changes for the dentist or the laboratory personnel in the process of fabrication of the prosthesis.
As mentioned by Tripathi et al.\textsuperscript{32} 2014, assessment and analysis of different additives such as cyanoacrylate, epoxy resin, and gum arabic incorporated to die stone was done. Thus, it was possible to evaluate these compounds’ binding capacity (adhesive property). Gum arabic when added to type IV gypsum had its property of abrasion resistance improved. But as it is also mentioned in the study that the compressive strength has a negative effect on the gypsum product and therefore addition of gum arabic is avoided.

Chandele et al.\textsuperscript{31} 2017, also mentioned in there study that a decrease in the gyypsum product’s compressive strength after gum arabic was added to the gyypsum product. He also tested the surface roughness by adding gum arabic of concentration 2% and calcium hydroxide of concentration 0.2%, but with both the disinfectant the result obtained was the same, that there was improvement in the surface roughness but decrease in compressive strength.

Abrasion resistance measured in our study, with the help of two body wear test, gave the result that there is no significant difference between the control and the experimental group. This tells us that the addition of chloramine-T doesn't have any unfavourable effect on the type-III gyypsum product compared to frequent disinfection with sodium hypochlorite and glutaraldehyde solution which reduces the resistance to abrasion.

Although the setting time in the clinical scenario was unchanged, the setting time increased by a statistically significant value 0.08 seconds when Chloramine-T was employed as a disinfectant, in contrast to earlier research where chlorhexidine (setting time increased by 45 seconds), and sodium hypochlorite (setting time increased by 75 seconds) solution were used for disinfection and the setting time was extended.\textsuperscript{20}

So as to prevent the spread of infection from one person to another, Chloramine- T should be used as a disinfectant by mixing it into the gypsum product as it prevents cross-infection and also does not have any detrimental effects on the physical properties of dental stone.

\textbf{Limitations}

- There are a number of factors that affect the usability of type III gyypsum products, such as setting expansion and impact resistance which are also to be considered.

- A more extensive and longitudinal study is required to provide more statistically significant data.

\textbf{Conclusions}

This study can pave the way for biologically safer dentistry. It has been suggested that the impressions are to be cleaned with a dependable and proven disinfection method. However, the reality on the ground offers a different tale. To further investigate the results of the combination between type III dental stone and Chloramine-T, testing other properties of type III gyypsum product like setting expansion of gyypsum product can be tested, as well as incorporating the disinfectant in other types of gyypsum products can be carried out for all-round application, as different type of gyypsum product has various uses. The ultimate goal of infection control could be one step closer with such advents in material sciences in dentistry.

The samples that were created by adding 0.05% Chloramine-T as a disinfectant were tested for their properties of setting time and abrasion resistance. However, within the constraints of this \textit{in-vitro} study the following conclusions were being formed:

The setting time was increased by 0.08 seconds when Chloramine-T was used as a disinfectant that was statistically significant value. However, the setting time in the clinical context was unaffected; the results for abrasion resistance revealed that neither the abrasion of dental stone increased nor decreased considerably; and because the physical features of dental stone are unaltered, the Chloramine-T disinfected dental stone can be utilised for all of its dental applications.

\textbf{Data availability}

\textbf{Underlying data}

Zenodo: Result for setting time, https://doi.org/10.5281/zenodo.7752166.\textsuperscript{33}

This project contains the following underlying data:

- Results for setting time.csv

Zenodo: Result of control group for abrasion resistance, https://doi.org/10.5281/zenodo.7755150.\textsuperscript{34}
This project contains the following underlying data:

- Results for control group of abrasion resistance.csv


This project contains the following underlying data:

- Results for experimental group of abrasion resistance.csv

Reporting guidelines


This project contains the following reporting guidelines

- STROBE-checklist-v4-cross-sectional.pdf

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

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