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Promising Role of Calcium Hypochlorite as a Disinfectant: An *in vitro* Evaluation Regarding its Effect on Type V Dental Stone

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ABSTRACT

Aim: The current study has been chosen to evaluate the efficacy of calcium hypochlorite as a disinfecting additive for the gypsum products and its effect on compressive and tensile strength of the set material. It is hypothesized that, the addition of calcium hypochlorite to type V dental stone in sufficient quantity to disinfect the material would have no deleterious effect on compressive or tensile strength.

Materials and methods: Total of 160 samples made up of type V dental stone were divided broadly into two groups of 80 samples each for the sake of compressive and tensile strength testing in dry and wet conditions: Out of each group, 10 samples without addition of any disinfectant (0% calcium hypochlorite) was compared with other group of 30 samples after adding disinfectant, i.e. each subgroup containing 10 samples each (0.5, 1.0 and 1.5% calcium hypochlorite).

Conclusion: Within limitations of this *in vitro* study it is assumed to prepare type V dental stone that contains a disinfectant, has adequate compressive strength and tensile strength, and can significantly act against a resistant species like *Bacillus subtilis*.

Clinical significance: When calcium hypochlorite was added to dental stone, extra mixing water was required to produce a material of nearly same pouring consistency. The samples, which were put to microbiological tests, showed effective action of disinfectant on *Bacillus subtilis*. No deleterious effect on compressive or tensile strength could be found after putting the selected samples with calcium hypochlorite.

Keywords: *Bacillus subtilis*, Calcium hypochlorite, Dental stone, Disinfection.

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INTRODUCTION

It is aptly confessed that, 'Mouth is the mirror of health'. As the oral environment is a suitable culture media for a huge number of microorganisms, there is potential risk involved for the personnel involved in treating this. The entire staff is routinely exposed to numerous viral and bacterial pathogens, which have implications to cause serious illness or death. At present much care has been reserved towards prevention of AIDS and hepatitis B transmission in dental office as well as laboratory. Although, primarily blood has been implicated in the transmission of AIDS, this virus (HIV) has also been isolated from saliva of infected individual.¹⁻⁴

According to the 'Centers for Disease Control (CDC)', blood and saliva should be thoroughly and carefully cleaned from material that had been used in the mouth (e.g. impression, bite registration, etc.). Special care should be taken before polishing and grinding intraoral devices. Contaminated materials, impressions and intraoral devices should be cleaned and disinfected before being handled in the dental laboratory and placed in a patient's mouth.⁵

Although it seems that, the chance of cross contamination is small when cast impressions are disinfected prior to pouring, it has been reported that critical steps in infection control is often missed. It is evident, then that, although methods of disinfecting impression may be effective, they are not always performed, thereby leaving dental personnel at risk. Back up procedures should be used in all laboratories which include those casts that may not have been properly disinfected prior to pouring stone.⁶

In this study, we selected calcium hypochlorite as a disinfectant because, it has many properties like, an ideal

disinfectant, including a broad spectrum antimicrobial activity, rapid bacterial action, reasonable persistence in treated portable water, ease of use, solubility in water, relative stability, relative nontoxicity, at use concentration, no poisonous residuals, no color, no staining and low cost. The active species is undissociated hypochlorous acid (HOCl). It was chosen in favor of sodium hypochlorite (liquid bleach), because of its more clinical stability and had greater available chlorine and lesser chemical effect on properties of dental stone.⁷

The aim was to find out the scope of developing a disinfectant with enough disinfecting ability in a dental set up. The objective was to find out the lowest concentration of calcium hypochlorite, which might be accepted as a standard to meet the challenges of newly emerging infection control protocol in preventive dentistry.

MATERIALS AND METHODS

Testing of Consistency of Materials

Two 10 mm diameter circular holes were cut into opposite side of a casting ring 4 cm high \times 3 cm in diameter (Shah Engineering Works, Ahmedabad, India). It was then placed over the sprue former (Prime Dental Co, India), and secured to the center of a 20 \times 15 cm ceramic tile with a small amount of boxing wax (Prime Dental Co, Mumbai, India). The tile was fastened to the vibrator. Then type V dental stone (Dentofl-HX, ISO: 6873-Type V, Prevest, Denpro Ltd, Digiana, Jammu, India) (Fig. 1), was mixed for 60 seconds and vibrated into the cylinder with the exit holes covered. Two minutes from the start of mixing, the holes in the cylinder were uncovered and the assembly was then vibrated for 10 seconds, allowing the stone to flow from the assembly. The slump of the material was allowed to reach its initial set and then the cylinder and sprue former were removed (Fig. 2). The length of slump was measured 5 times and average distance was measured with a measuring scale.⁸

Microbiological Testing

A maxillary 2nd premolar typodont tooth (Pyrax polymars, Roorkee, India) was embedded in a block of plaster of Paris to the gingival extent of the crown and allowed to set. Irreversible hydrocolloid impressions (septodont) were taken on the typodont tooth using small boat shaped structures as impression trays made up of addition silicones (3M ESPE) (Figs 3 and 4). The impression was wicked dry with disposable wipe. Then 0.2 ml buffer (0.05M HCl, 0.1M NaCl, 0.01M MgCl₂) (Fig. 5A){Magnesium chloride (Burgoyne burbridges and Co, India) (see Fig. 1) and Hydrochloric acid, Sodium chloride, distilled water and electronic weighing machine from biochemical laboratory, BJ Medical College, Ahmedabad, India} was added into it. *Bacillus subtilis* {culture media, pipette and microbiological



Fig. 2: Test of consistency by measuring the length of slump



Fig. 1: Materials used for experiment (Type V Dental Stone, calcium hypochlorite, magnesium chloride)



Fig. 3: Typodont premolar and boat-shaped specimens prepared for impression making



Fig. 4: Alginate impression over typodont premolar



Fig. 6: Specimens prepared of type V dental stone and its incubation



Fig. 5A: Chemical (0.05M HCl, 0.1M NaCl, 0.01M MgCl₂) used as buffer for growth of *Bacillus subtilis*



Fig. 5B: Different concentration of disinfectants $[1.5\% \text{ Ca(OCI)}_2$ 1.0% Ca (OCI)₂, 0.5% Ca(OCI)₂]

apparatus from BJ Medical College, Microbiology Lab, Ahmedabad, India} was incubated into it (Fig. 6). After 5 minutes at ambient temperature, the said solution was removed and the impression wicked dry again.⁹ Within 1 minute, a stone solution containing calcium hypochlorite (0, 0.5, 1, and 1.5% solutions) (Sidifine chem. Ltd, Mumbai, India) (Figs 1 and 5B) was mixed and poured into the impression and allowed to set for 1 hour.

Method followed by the Microbiologist

Large gram positive/ gram variable bacilli culture was taken from prepared media (Fig. 7). It was found to be catalase positive. The catalase test with 3% hydrogen peroxide rules out clostridial species due to absence of bubbling. Voges-Pros Kaues test was employed on it which was found to be positive.¹⁰ Citrate was added into it which is again positive. Maltose was added on to it, which showed negative result confirming the presence of Bacillus subtilis. Peptone water was added to watch the turbidity and the same was compared with McFarland standard.¹⁰ Calcium hypochlorite was added in different concentrations to all samples with the help of pre-sterilized pippetting tips (Fig. 8). All the disinfected samples were put into peptone water and checked for turbidity after 18 hours at the incubation temperature of 37°C. No turbidity was visible after that. For further confirmation, blind subculture in blood agar was done for 18 hours at 37°C and checked for growth.

Strength Testing

Cylindrical molds of 10 mm in height and 5 mm in diameter were prepared with wax and vibrated after putting dental

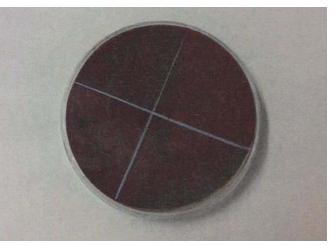


Fig. 7: Culture media of Bacillus subtilis

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Fig. 8: Inoculation of Bacillus subtilis into the prepared specimen

stone into it. Total no. of specimens was 160. They were divided into two broad groups, e.g. 80 for dry strength testing and others for wet strength testing. Again each group was subdivided for compressive strength and tensile strength testing, which were compared before and after adding any disinfectant (Fig. 6).

For wet strength testing, specimens were stored in air, at room temperature $(30^\circ \pm 4^\circ \text{C})$ and $(70 \pm 10\%)$ relative humidity until they were crushed at 1 hour from the start of mixing. For dry strength testing, specimens were stored under the same conditions for 24 hours and then incubated at 37°C for 7 days. For compressive strength testing, the samples of above dimensions were placed vertically in an unconfined compression test apparatus (Department of Biomechanics, LD Engineering College, Ahmedabad, India) for CBR (California bearing ratio) test (D2-54) (Figs 9A to D).

CBR = The force required to press soil or aggregate specimen for a certain distance divided by the force required to press a standard specimen.^{11,12}

The standard is specified by National Physical Laboratory (NPL), New Delhi India. In this case the standard was '3.21 division in dial gauge = 1 kg force'. This measuring instrument was chosen because of small size of specimens. The samples were compressed till crushed and readings were taken for each.

Calculation: Measured force (In kg wt.) = Number of division counted on dial gauge at break point/3.21.

Measured surface area = $10 \times 5 = 50 \text{ mm}^2 = 0.00005 \text{ m}^2$ Measured stress = Force/Area

By above method, stress was calculated in relation to strain, which in turn gives us measure of compressive strength.

For tensile strength testing, similar preparations of specimens were made and two groups were prepared for wet and dry tensile strength testing. The samples were put



Fig. 9A: California bearing ratio (CBR) testing machine for compressive strength testing



Fig. 9B: Close view of vertical placement of specimen.



Fig. 9C: Compressive strength testing with dial gauge attached

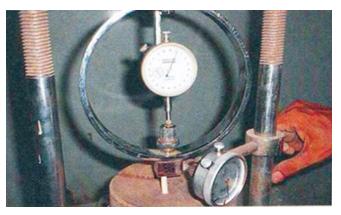


Fig. 9D: Compressive strength testing till failure of bond

into the tensile strength tester (Alekh plastics testing centre, Vatva, Ahmedabad) and crushed until failure of the bond (Figs 10A to C).

RESULTS

When calcium hypochlorite was added to dental stone, extra mixing water was required to produce a material of nearly same pouring consistency (Table 1). After microbiological testing, effective action of disinfectant was shown on



Fig. 10A: Tensile strength tester



Fig. 10B: Close view of specimen, placed inside Tensile strength tester



Fig. 10C: Specimen after bond failure

Table 1: Con	· · · · · · · · · · · · · · · · · · ·	r control and e al stone	xperimental type V
Dentoflo-HX	Percentage of calcium hypochlorite	Water (ml)	Consistency ± SD (mm)
50 gm	0	11	145.55 ± 1.20
50 gm	0.5	12.5	145 ± 2.70
50 gm	1.0	12.5	144 ± 3.45
50 gm	1.5	12.5	145 ± 2.63

Bacillus subtilis at all concentrations (Table 2). Dry compressive strength (DCS) (Tables 3A and B), wet compressive strength (WCS)) (Tables 4A and B), dry tensile strength (DTS))(Tables 5A and B) and wet tensile strength (WTS) (Tables 6A and B) were compared. These values were put into statistical analysis through one-way ANOVA (Table 3). In our observations, we analyzed data according to 95% of confidence interval. Hence, p > 0.05 is considered as statistically insignificant.

DISCUSSION

In prosthodontics, the sources of transmission may be impression trays, impression materials before and after making impressions, gypsum casts, bite blocks, try-ins and prostheses. Thus, a vicious cycle of cross-contamination ensures spread of infection exposing dentists, dental surgery staff, laboratory personnel, patient to patient transmission and finally, spread of disease.⁴

Potential cross-contamination through impression materials like alginate, polyether and polyvinylsiloxane materials has been evaluated. It was opined that, simple rinsing of impressions in sterile water reduced the number of microorganisms significantly, but could not decontaminate the impressions. Alginate impressions produced significantly higher levels of contamination than polyvinylsiloxane and polyether impressions from the same individual (p < 0.05).¹³

It is therefore desirable to have an economic and convenient measure of control of contamination. In this work, calcium hypochlorite is chosen as an alternative because of its well known disinfection properties. It is also hypothesized that the calcium salt would have less effect on structure and properties of calcium sulfate-dihydrate compared to sodium hypochlorite. The first observed effect of calcium hypochlorite was an increase in water requirement of the material, which led to set gypsum with greater porosity.

The other overall trend was that, the more the disinfectant was added, the weaker the compressive and tensile strength. This is consistent with what is known in general about dental stones, in that, inorganic additives Promising Role of Calcium Hypochlorite as a Disinfectant: An in vitro Evaluation Regarding its Effect on Type V Dental Stone

	Table 2: Microbiological data	ata after <i>Bacillus subtilis</i> inoculat within irreversible hydrocolloid		ar tooth merged
Percentage of calcium hypochlorite	Inoculation of Bacillus subtilis culture	Addition of buffer of 0.05 M HCl, 0.01 MNaCl, 0.01 M MgCl ₂	Time allowed for action of disinfectant	Result showing presence/ absence of Bacillus subtilis
0	Yes	Yes	1 hour	Present
0.5	Yes	Yes	1 hour	Absent
1.0	Yes	Yes	1 hour	Absent
1.5	Yes	Yes	1 hour	Absent

Table	3: Overall comparison of	compressive and tensile stre	ngth of dental stone (mean	± SD)
Percentage of	Dry compressive strength (KPa)	Wet compressive	Dry tensile	Wet tensile
calcium hypochlorite		strength (KPa)	strength (KPa)	strength (KPa)
0	377.57 ± 21.82	246.73 ± 37.63	82.24 ± 12.04	34.27 ± 6.73
0.5	382.02 ± 10.02	245.27 ± 14.93	84.50 ± 10.47	34.40 ± 5.62
1.0	383.67 ± 11.36	243.22 ± 19.48	84.02 ± 11.56	34.45 ± 4.65
1.5	379.02 ± 11.09	246.40 ± 21.99	85.32 ± 9.95	31.30 ± 3.62

reduce their strength.¹⁴ However, the current study could not find any change, neither in compressive nor in tensile strength after adding calcium hypochlorite.

The control specimens were compared with this organism-induced solution for further investigations. This agrees with the findings for dental casts made from impressions contaminated with bacteria can be a medium for cross-contamination.^{7,15} The current sample contained minimum of 35.0% available chlorine (see Fig. 1). This amount of chlorine was found to be enough to remove whole *Bacillus subtilis* strains.

Calcium hypochlorite and it's use in health care facilities has been strongly advocated by WA Rutala and DJ Weber. Hypochlorites formed from calcium hypochlorite, are lethal to most microbes, although viruses and vegetative bacteria are more susceptible than endospore forming bacteria, fungi, and protozoa.¹⁶

It is found that the weakest stones are clearly much stronger than the strongest plasters.¹⁷ However, this difference is greater in case of compressive strength than in tensile strength. Plaster is 35 to 40% as strong as stone in compression, but 65 to 70% as strong in tension. This ratio applies to the materials both in wet and dry state. However, the distinction between stones and die stones is not so clear with respect to strength properties. The strongest die stones are stronger than the strongest stones, both in tension and compression; at the same time there is some overlapping between the two groups. The weakest die stones are no stronger than the strongest stones. In our study, we are in agreement with these findings and hence preferred the type V dental stone as our testing material which may be a standard for comparison among gypsum products.

Repeated immersion in tap water or slurry water is strongly discouraged in literature.¹⁸When soaking or rinsing

is necessary, the cast should be rinsed in water saturated with calcium sulfate, not in tap water. On this very basis, we preferred a disinfectant containing calcium as its component rather than water. Abdulla MA also agreed with the notion that, repeated immersion of type III and IV stone specimens in slurry with distilled water and 0.525% sodium hypochlorite, alongwith drying in air, caused a significant increase in linear dimension and a significant decrease in wet compressive strength.¹⁹ But he stated that, though both solutions caused some degree of damage to surface details for type III and IV stones, the difference was not significant. Study on influence of different methods of chemical disinfection on physical properties of type IV and V dies also provided with same result. Chemical disinfectants did not cause significant dimensional alterations in these dies; superficial texture was altered according to disinfection method utilized. But immersion in disinfectant solution during 30 minutes, as well as the addition of disinfectant to the gypsum during preparation, reduced the compression resistance of dies.²⁰ Another author showed that, there are significant difference among brands of impression materials and that those should be considered during selection of an appropriate disinfectant.²¹ Contradictory reviews opined that, surface roughness of stone casts was adversely affected by using the disinfectant solutions as mixing water substitutes. Gum Arabic and calcium hydroxide additives can yield a harder stone surface without compromising other surface properties.²²

They also reported greater surface deterioration following addition of sodium hypochlorite as disinfectant. But one author disputed this claim by concluding that, using aqueous solutions of either sodium or calcium hypochlorite disinfectants by substituting water in mixing dental stone, it is possible to obtain a dental stone cast with comparable

862			Table 3A: DCS b	efore (0% calcium	Table 3A: DCS before (0% calcium hypochlorite) and after addition (0.5, 1.0 and 1.5% calcium hypochlorite)	fter addition (0.5, 1	.0 and 1.5% calciun	n hypochlorite)		
		% of calcium	Sample size N	Mean	Std. deviation	Std. error	95% confidence interval for mean	interval for mean	Minimum	Maximum
		hypochlorite	Lower bound	Upper bound	Lower bound	Upper bound	Lower bound	Upper bound	Lower bound	Upper bound
	Force (N) analysis	0 0.50 1.00 1.50	0000	18.8786 19.0981 19.1835 19.4110	1.09098 0.50181 0.56808 0.53251	0.34500 0.15869 0.17964 0.16840	18.0981 18.7391 18.7772 19.0301	19.6590 19.4570 19.5899 19.7919	17.13 18.24 18.25 18.38	20.25 19.84 19.87 20.20
		Total	40		0.71413	0.11291	18.9144	19.3712	17.13	20.25
	Stress (N/M ²) analysis	0 0.50 1.00 1.50	0 1 0 1 0 0 0	382020.4000 383670.7520 379019.9740	19.1428 377570.0300 11361.57694 11098.91270	6900.62565 3170.45563 3592.84610 3509.16990	361959.7303 374848.3311 375543.1695 -54954.5935	393180.3297 389192.4689 391798.3345 1532994.5415	342679.10 364715.00 364984.42 367695.28	404984.40 396715.00 397429.78 3897705.42
		Total	40	470570.2890	555954.28220	87904.09033	292767.4836	648373.0944	342679.10	3897705.42
	DCS: Dry compressive strength	trength								
				Table 3B:	3B: Statistical analysis (one-way ANOVA) of DCS	(one-way ANOVA)) of DCS			
				Sum of squares	res	df	Mean square		F	Sig.
	Force (N) analysis	Between groups Within groups	Jroups ups	1.454 18.435	1.454 18.435	36 36	0.485 0.512		0.946	0.428
		Total		19.889	389	39				
	Stress (N/M ²) analysis	Between groups Within groups		961068939233.931 11093252452825.640	331 340	36 36	320356313077.977 308145901467.379		1.040	0.387
		Total		12054321392059.570	570	39				
		Ĥ	Table 4A: WCS before (0% calciu	fore (0% calcium h	m hypochlorite) and after addition of (0.5,	er addition of (0.5,	1.0 and 1.5%) calcium hypochlorite	ium hypochlorite		
		% of calcium	Sample size N	Mean	Std. deviation	Std. error	95% confidence interval for mean	interval for mean	Minimum	Maximum
-		outoutoodku	Lower bound	Upper bound	Lower bound	Upper bound	Lower bound	Upper bound	Lower bound	Upper bound
	Force (N) analysis	0 0.50 1.50	0 0 0 0	12.3366 12.2547 12.1610 12.3201	1.88164 0.75081 0.97434 1.09985	0.59503 0.23743 0.30811 0.34780	10.9905 11.7176 11.4640 11.5333	13.6826 12.7918 12.8580 13.1068	9.97 11.21 10.60 10.53	16.20 13.58 13.83 13.93
		Total	40	12.2681	1.20427	0.19041	11.8829	12.6532	9.97	16.20
4	Stress (N/M ²) analysis	0 0.50 1.00	<u>6 6 6 6</u>	246731.0000 245274.6200 243220.3340	37632.79393 14931.59068 19486.88832	11900.53435 4721.78356 6162.29516	219810.1210 234593.2035 229280.2539	273651.8790 255956.0365 257160.4141	199400.00 224291.00 211965.82	323987.00 271580.00 276581.58
d:		0G.T	DI.	246400.9520	70176.06617	01.500.0060	C007.C00U27	6/20.021202	09.680012	86.176872
		Total	40	245406.7265	24072.78805	3806.24199	237707.8754	253105.5776	199400.00	323987.00
	WCS: Wet compressive strength	strength								

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			Tahla /B.	Table 18: Statistical analysis (one-way ANOVA) of WCS	I ANONA WEW-EAD	of MICS			
				טומווסווטמו מו ומוץסוס	(WANNA WAND)				
			Sum of squares	es	df	Mean square		F	Sig.
Force (N) analysis	Between groups Within groups	sdr sdr	0.190 56.370	90 70	3 36	0.063		0.041	0.989
	Total		56.560	60	39				
Stress (N/ M^2) analysis	Between groups Within groups	roups	75399489.391 22525066364.800	191 00	36 36	25133163.130 625696287.912		0.040	0.989
	Total		22600465854.190	06	39				
	F	able 5A: DTS bef	ore (0% calcium hy	pochlorite) and afte	er addition of (0.5,	Table 5A: DTS before (0% calcium hypochlorite) and after addition of (0.5, 1.0 and 1.5%) calcium hypochlorite	im hypochlorite		
	% of calcium	Sample size N	Mean	Std. deviation	Std. error	95% confidence interval for mean	nterval for mean	Minimum	Maximum
	hypochlorite	Lower bound	Upper bound	Lower bound	Upper bound	Lower bound	Upper bound	Lower bound	Upper bound
Force (N) analysis	0	10	4.1121	0.60193	0.19035	3.6816	4.5427	3.12	4.98
	0.50	10	4.2251	0.52344	0.16553	3.8506	4.5995	3.36	4.98
	1.00	10	4.2011	0.57840	0.18291	3.7873	4.6148	3.24	4.99
	1.50	10	4.2665	0.49786	0.15744	3.9103	4.6226	3.74	5.00
	Total	40	4.2012	0.53340	0.08434	4.0306	4.3718	3.12	5.00
Stress (N/M ²) analysis	0	10	82243.6900	12040.28745	3807.47320	73630.5872	90856.7928	62305.30	99688.47
	0.50	10	84500.1746	10470.44340	3311.04493	77010.0706	91990.2786	67227.56	99688.47
	1.00 1.50	10 0	84021.6648 85329.7668	11568.05921 9957.12426	3658.14152 3148.71916	75746.3738 78206.8692	92296.9558 92452.6644	64751.17 74766.36	99704.63 99969.16
	Total	40	84023.8241	10668.76582	1686.87999	80611.7872	87435.8609	62305.30	99969.16
DTS: Dry tensile strength									
			Table 5B:	Table 5B: Statistical analysis (one-way ANOVA) of DTS	(one-way ANOVA)	of DTS			
			Sum of squares	es	df	Mean square		F	Sig.
Force (N) analysis	Between groups Within groups	roups rroups	0.128 10.968	28 68	3 36	0.043 0.305		0.140	0.936
	Total		11.096	96	39				
Stress (N/M ²) analysis	Between groups Within groups	sdr	51012782.111 4388067218.321	11 21	3 36	17004260.704 121890756.065		0.140	0.936
	Total		4439080000.431	31	39				
Df: Degrees of freedom,									

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Sig: Significance

II LL

Estimate of population variance based on between samples variance Estimate of population variance based on within samples variance

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% of calciumSample size NMeanSuch deviationSuch and townMinimumfilp of calciumLower boundUpper boundUpper boundUpper boundUpper boundUpper boundLower boundsist0.5101/12140.336490.106411/1227195411.251.00101/17140.230280.03555115663192811.241.00101/17270.230280.0173551156631168431.241.100101172270.250580.01755531451493249212alvis0.010342681376731.283372128.6193217714962452.6435117647alvis0.01034268.91376571.63932128.619321775.86933867.36952477590alvis0.01034268.91376520.6649311777.140830415.861533865.885124922.12alvis0.00.01034268.91376520.6649311777.140830415.861624922.12alvis0.00.0103436.14125520.6545831420.865624922.12alvis0.00.0114.495182973.815935594.457224717.90alvis1.51.430.7352.63504.457224717.90alvis0.0103265.05453456.86332477.5692477.90alvis1.51.430.7352.635294.457224717.90alvis103361.41766554.0311	$\begin{tabular}{ c $	% of calactum Sand Numm Sand Sand Sand Mimm Mimm 8 0.50 10 1.7213 Construint Lower bound										
Inportionity Lower bound Lower bound <thlower bound<="" th=""> <thlower bound<="" th=""></thlower></thlower>	Important Lower bound Upper bound Lower bound Upper bound Lower bound <thlower bound<="" th=""> <thlower bound<="" th=""></thlower></thlower>	Improductione Lower bound Opper bound Opper bound Opper bound Opper bound Opper bound Improductione Lower bound Opper bound Opper bound Opper bound Opper bound Improductione Improductin Improductin Imp		% of calcium	Sample size N	Mean	Std. deviation	Std. error	95% confidence	interval for mean	Minimum	Maximum
51 0 11 </th <th>51 0 17134 0.3564 0.0681 1.4721 1.524 1.25 1.25 1 1 0 1.7216 0.23260 0.07355 1.4354 1.6944 1.2 1 1 0 1.7216 0.23260 0.07355 1.4354 1.6944 1.2 1 1 0 1.17210 0.07355 0.071505 3846.3837 2422.12 490 1 0 31436.4174 5620.36345 1777.31490 37761.400 3466.3837 2432.12 436 1 0 3445.4176 5620.36345 1777.31490 37761.205 3846.5837 2432.12 436 1 1 40 3453.0326 554.417 560.33536 3646.5856 3436.5856 3445.7 2437.10 357 1 1 40 3456.4715 57.4457 2471.90 2432.12 345 1 1 40 3464.475 54.4457 2471.490 2471.490 245 <</th> <th>Sist 0 11134 0.08647 1472 1954 125</th> <th></th> <th>hypochlorite</th> <th>Lower bound</th> <th>Upper bound</th> <th>Lower bound</th> <th>Upper bound</th> <th>Lower bound</th> <th>Upper bound</th> <th>Lower bound</th> <th>Upper bound</th>	51 0 17134 0.3564 0.0681 1.4721 1.524 1.25 1.25 1 1 0 1.7216 0.23260 0.07355 1.4354 1.6944 1.2 1 1 0 1.7216 0.23260 0.07355 1.4354 1.6944 1.2 1 1 0 1.17210 0.07355 0.071505 3846.3837 2422.12 490 1 0 31436.4174 5620.36345 1777.31490 37761.400 3466.3837 2432.12 436 1 0 3445.4176 5620.36345 1777.31490 37761.205 3846.5837 2432.12 436 1 1 40 3453.0326 554.417 560.33536 3646.5856 3436.5856 3445.7 2437.10 357 1 1 40 3456.4715 57.4457 2471.90 2432.12 345 1 1 40 3464.475 54.4457 2471.490 2471.490 245 <	Sist 0 11134 0.08647 1472 1954 125		hypochlorite	Lower bound	Upper bound	Lower bound	Upper bound	Lower bound	Upper bound	Lower bound	Upper bound
050 10 17218 0.03102 0.03555 1.500 1.924 1.24 1500 10 1.7217 0.03755 1.5663 1.7647 1.24 1.37 alval 1.50 10 1.727 0.23288 0.01735 1.5663 1.7647 1.24 1.37 alval 1.50 10 34268.9137 6731.28337 2128.61870 2945.6483 37781.4093 2477.290 4365 alval 10 3425.802 3626.3438 1141.45138 3964.1837 2492.212 4365 1.50 10 31237.3250 3620.65418 1141.45138 31781.26357 3486.9332 2477.290 4365 1.50 10 31297.3250 3620.65418 1141.45138 31781.26357 3486.9322 2477.290 4365 1.50 1.50 1144.95138 31781.26356 31781.26356 37781.4009 5768.51 3946 1.50 1.50 144.9513 3176.2556 31381.50 35594.4572 2477.790<	050 010 17210 02810 1200 121 150 0 17217 0.016103 1.5967 1.5967 1.597 1.24 150 0 1.5649 0.16103 0.07355 1.5967 1.24 1.24 anbysi 0 1.600 0.2508 0.04153 1.5967 1.24 1.24 anbysi 0 10 34268.417 650.36345 1.17643 3.2425.913 3041.8930 3041.8930 3042.86913 3042.9491 940 1.100 10 3436.8417 650.36345 1.140.9138 3041.8565 3465.9832 2471.900 490 1.100 10 3436.8417 650.36345 1.140.9138 30715.2650 3387.3850 24717.90 490 1.101 10 3436.41136 650.65418 1.140.9138 28707.2850 3387.3850 24717.90 490 1.101 10 3456.4136 650.65418 1.140.9138 28707.2850 3387.3859.4457 24717.90 4	100 11218 028102 008875 1563 1328 123 150 10 17278 023165 003725 15643 1237 123 150 10 17275 023565 15643 15643 1237 128 137 150 10 3456417 6713833 771565 39041837 2477.90 2456 150 10 3456417 6714833 31752865 3771490 2477.90 200 150 1436417 820.365418 1144.45138 34456.8655 37714.900 277565 3771.600 3966 150 150 3267.36543 1144.45138 37712656 3771.400 2477.90 2477.90 2495 16 strutt 80.3125265 3261.4512 80.45857 3771.468.93 3771.468.93 3771.468.93 3771.468.93 3771.468.93 3771.468.93 3771.468.93 3771.468.93 3771.468.93 3771.468.93 3771.468.93 3771.468.93 3771.468.93 3771.468.93 3771.468.93	⁻ orce (N) analysis	0	10	1.7134	0.33649	0.10641	1.4727	1.9541	1.25	2.18
1.00 10 1.727 0.2356 0.07355 1.5663 1.881 1.24 1.00 10 1.5643 0.19103 0.05735 1.4554 1.6944 1.37 1.10 10 1.5643 0.16103 0.05735 1.5667 1.6844 1.24 1.10 10 3456.417 6520.35345 1.4354 3456.5832 2492.12 436 1.50 10 3456.417 6520.35345 1141.96138 30415.8816 3456.5832 2492.12 436 1.50 10 3445.8802 5554.0311 807.75650 3387.3803 2477.90 436 1.50 1.50 3456.8813 3126.7295 31287.3803 2477.90 400 1.50 144.44.9613 80.75560 3133.3159 3524.457 2477.90 400 1.51 1.50 3456.383 3126.793 3367.3803 2477.50 2477.90 401 1.51 1.51 80.7556.074 Mean square 5794.457 54	100 100 1727 0.03536 15663 15663 15694 124 150 0 16040 0.6570 0.16755 15664 16944 137 150 10 15640 0.16753 15967 15643 124 124 alysis 0 10 342689137 671.28336 177616 3456853 3464.1837 24327.29 3456 100 10 34358417 560.05418 1747.0865 3464.8932 24372.10 3456 1100 10 34436417 560.05418 1747.0865 3464.8932 24372.10 3457 1150 1160 34586186 1144.96138 3807.2660 3387.3860 3775.96 3967 1150 10 34787.25 5524.4571 8307.2660 3387.3860 3775.96 3967 1151 10 3775.66 3387.3860 3775.96 3529.4575 2477.59 397 1141 141.366 5524.0311 807.75660	100 10 1727 023260 0.07355 1.5603 1.6801 1.24 150 0 1600 1.6607 0.07355 1.4351 1.5934 1.37 150 0 160 0.52560 0.04155 1.4351 3456.436 1.24 2.452.12 4365 100 10 34268.417 650.6418 1.470.68653 31041.5856 3456.4362 3456.4183 2.4577.50 3452.12 4365 150 10 34268.4174 650.66418 1.470.68653 31041.5856 3476.9509 2477.500 </td <td></td> <td>0.50</td> <td>10</td> <td>1.7218</td> <td>0.28102</td> <td>0.08887</td> <td>1.5208</td> <td>1.9228</td> <td>1.25</td> <td>2.18</td>		0.50	10	1.7218	0.28102	0.08887	1.5208	1.9228	1.25	2.18
I.50 10 1.544 0.18103 0.05725 1.4547 1.694 1.37 Total 40 1.6807 0.26568 0.04153 1.5667 1.7647 1.24 3303 alytic 0.50 10 342681317 6731.28337 2128.61870 29453.6436 30084.1837 24322.12 4365 alytic 10 34458.9177 6731.28337 2126.5856 33034.1837 24322.12 4365 alytic 10 34438.4174 652.035348 1777.31498 3044.1837 24322.12 4365 alytic 10 31297.3250 352.045418 1144.96138 31761.4999 2477.909 2477.909 4365 cist 11.00 31297.3250 352.04.011 80.73565 3387.3860 2477.90 4365 cist 11.414.96138 1144.96138 2477.90 2477.90 2477.90 2477.90 2477.90 2477.90 2477.90 2477.90 2477.90 2477.90 2477.90 2477.90 2477.90 2	I.50 10 1564 0.16103 0.05725 1.434 1.37 1.37 Tolal 40 16807 0.04153 1.5667 1.7647 1.24 365 anyos 0.50 10 3458.6133 573.13333 2175.61670 39064.1687 24922.12 436 100 10 34435.8114 560.5418 144.95138 3904.1586 3476.14000 2777.31.03 3475 3906 3906 360 3906	I.50 10 15640 018103 005755 1.4364 1.37 1.31 Tabil 40 1.6607 0.25368 0.04153 1.5967 1.744 1.24 343 Tabil 40 1.607 0.25368 0.041533 2453.4336 2466.9332 2475.3148 30041.837 2422.12 3436 150 10 3435.802 4651.6648 1477.3148 3015.82563 34781.400 2477.19 390 1100 10 3435.802 4651.6648 1144.95138 2877.72560 3504.4572 2477.90 390 1100 3361.1366 524.0311 8307.3326 31287.3326 31287.3369 2471.90 2778.61 396 1100 3454 1 303 3524.457 2471.90 273 394 111 41.95138 01 144.95138 3274.457 2471.90 2471 111 111 30.3331.165 3293.457 2471.90 2471 2471 111 <td></td> <td>1.00</td> <td>10</td> <td>1.7227</td> <td>0.23258</td> <td>0.07355</td> <td>1.5563</td> <td>1.8891</td> <td>1.24</td> <td>2.00</td>		1.00	10	1.7227	0.23258	0.07355	1.5563	1.8891	1.24	2.00
Total 40 1.6807 0.26268 0.04153 1.567 1.7647 1.24 nalysis 0.50 10 34268.9137 6731.28337 2128.61670 39465.9553 24922.12 4362 nalysis 0.50 10 34268.80137 6731.28337 2128.61670 39456.9363 24922.12 4362 1.50 10 34263.8053 3601.6418 1141.96158 3041.6365 33481.3800 24377.300 24377.300 24377.300 24377.300 24377.300 24367.3650 33467.3850 34377.360 34567.377.360 3457.377.360 <t< td=""><td>Total 40 1.607 0.26268 0.04153 1.567 1.7647 1.24 nalysis 0 10 34453.8317 6731.28337 2128.61870 29453.6436 33084.1837 24322.12 4365 nalysis 0 10 34453.83477 6731.28337 2128.6187 29453.6456 24472.02 24372.02 33087.1805 24372.02 3465 1.50 10 31297.3250 31297.3250 3128.12863 3714.6305 24772.01 490 1.50 1.50 31297.3250 32614.1366 5254.0311 830.73556 31933.8159 3524.4572 2477.201 490 1.50 1.50 3261.1366 5254.0311 830.73556 31933.8159 3524.4572 2477.50 340 1.51 A 2 2 2 46 46 46 46 46 46 46 46 46 46 46 46 46 46 46 46 47 47 47 47</td><td>Total 40 16607 0.26268 0.04153 1.5647 1.7647 1.24 albysic 0 10 34368137 6731123337 2128 61970 343681932 243212 3436 3436 3436 34361 3436516316 34561616 34561616</td><td></td><td>1.50</td><td>10</td><td>1.5649</td><td>0.18103</td><td>0.05725</td><td>1.4354</td><td>1.6944</td><td>1.37</td><td>1.97</td></t<>	Total 40 1.607 0.26268 0.04153 1.567 1.7647 1.24 nalysis 0 10 34453.8317 6731.28337 2128.61870 29453.6436 33084.1837 24322.12 4365 nalysis 0 10 34453.83477 6731.28337 2128.6187 29453.6456 24472.02 24372.02 33087.1805 24372.02 3465 1.50 10 31297.3250 31297.3250 3128.12863 3714.6305 24772.01 490 1.50 1.50 31297.3250 32614.1366 5254.0311 830.73556 31933.8159 3524.4572 2477.201 490 1.50 1.50 3261.1366 5254.0311 830.73556 31933.8159 3524.4572 2477.50 340 1.51 A 2 2 2 46 46 46 46 46 46 46 46 46 46 46 46 46 46 46 46 47 47 47 47	Total 40 16607 0.26268 0.04153 1.5647 1.7647 1.24 albysic 0 10 34368137 6731123337 2128 61970 343681932 243212 3436 3436 3436 34361 3436516316 34561616 34561616		1.50	10	1.5649	0.18103	0.05725	1.4354	1.6944	1.37	1.97
nalysis 0 10 34268,9137 6731.28337 2128.61870 29453.6436 3004.1837 24922.12 2492.12 </td <td>Indivision 0 0 3456.9137 6731.28337 2128.61870 2945.64932 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 2492</td> <td>Indivision 0 10 34268.913 (5731.28337) 5731.28337 (5731.28335) 2435.36335 2415.36332 (5436) 2435.2132 (5436) 2432.12 (5436) 2432.12 (5436) 2432.12 (546) 2432.12 (546) 2432.12 (546) 2432.12 (546) 2432.12 (546) 2435.3650 2132.5650 33387.3650 23328.73560 23328.73560 2342.12 (546) 2432.12 (546) 2432.12 (546) 2432.12 (546) 2432.12 (546) 2435.3650 2332.457 2432.12 (547) 2432.12 (547) 2437.12 (540) 2435.3650 23387.3650 23387.3650 23328.73560 23328.73560 23328.73560 23328.73560 23328.73560 23328.73560 2347.7500 2347.7500 2338.73660 2347.7500 2338.73560 2338.73560 2338.73560 2338.73560 2347.7500 2477.7500</td> <td></td> <td>Total</td> <td>40</td> <td>1.6807</td> <td>0.26268</td> <td>0.04153</td> <td>1.5967</td> <td>1.7647</td> <td>1.24</td> <td>2.18</td>	Indivision 0 0 3456.9137 6731.28337 2128.61870 2945.64932 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 24922.12 2492	Indivision 0 10 34268.913 (5731.28337) 5731.28337 (5731.28335) 2435.36335 2415.36332 (5436) 2435.2132 (5436) 2432.12 (5436) 2432.12 (5436) 2432.12 (546) 2432.12 (546) 2432.12 (546) 2432.12 (546) 2432.12 (546) 2435.3650 2132.5650 33387.3650 23328.73560 23328.73560 2342.12 (546) 2432.12 (546) 2432.12 (546) 2432.12 (546) 2432.12 (546) 2435.3650 2332.457 2432.12 (547) 2432.12 (547) 2437.12 (540) 2435.3650 23387.3650 23387.3650 23328.73560 23328.73560 23328.73560 23328.73560 23328.73560 23328.73560 2347.7500 2347.7500 2338.73660 2347.7500 2338.73560 2338.73560 2338.73560 2338.73560 2347.7500 2477.7500		Total	40	1.6807	0.26268	0.04153	1.5967	1.7647	1.24	2.18
0.50 10 3436.4174 5620.36345 1777.3149B 30415.8516 3846.9832 24922.12 1 1.00 10 31297.3250 4651.66498 1144.95138 28707.2650 33887.3850 24717.90 2 1.100 10 31297.3250 5524.03111 830.73526 31933.8159 35294.4572 24717.90 2 1 estrength Image: Second state in the state in	0.50 10 34436,4174 6520,36345 1777,31436 30415,8516 3346,6932 24377,900 24777,	0.50 10 3436.3414 5520.3535 1777.31408 30415.8516 3781.800 2427120 7 1.00 10 3425.3802 3265.6418 1140.95186 31126.2805 3771.500 242712 242712 242712 242712 2477.900 2758651 2758616 2758616 2758616 2758616 2758616 2758616 2758616 2477.900 2758651 242712 2477.900 2758651 2437752 2477.900 275861 2477.900 2 2477.900 2 2437.850 27586161 2477.900 2 2477.900 2 2477.900 2 2477.900 2 2 2477.900 2 2 2477.900 2 <td>stress (N/M²) analysis</td> <td>0</td> <td>10</td> <td>34268.9137</td> <td>6731.28337</td> <td>2128.61870</td> <td>29453.6436</td> <td>39084.1837</td> <td>24922.12</td> <td>43623.71</td>	stress (N/M ²) analysis	0	10	34268.9137	6731.28337	2128.61870	29453.6436	39084.1837	24922.12	43623.71
1.00 10 3453.8902 4551.66498 1470.98563 31267.2850 33887.4800 24717.90 2 1.50 10 31297.3250 3620.65418 1144.95138 28707.2650 33887.3850 23738.51 2 I.50 10 31297.3250 5524.03111 830.73526 31933.8159 35294.4572 2<	1.00 10 3453.8902 4651.66498 1470.98563 31781.4909 2471.390 2471.390 2471.390 2471.390 2471.390 2471.390 2471.390 2471.390 2471.390 2471.390 2471.390 2471.390 2441.351 2441.355 244.525 2471.390 244.355 244.52 2471.390 244.355 244.52 2471.390 244.355 244.52 2471.390 244.355 244.52 2471.390 244.355 244.52 2471.390 244.355 244.52 244.52 244.355 244.52 244.52 244.52 2471.390 244.52 244.52 2471.390 244.52 2471.360 244.52 2471.360 244.52 2471.360 244.52 2471.360 244.52 2471.360 244.52 2471.360 244.52 2471.360 244.52 244.52 2471.360 244.52 2471.360 2471.360 244.52 2471.360 244.52 244.52 244.52 244.52 244.52 244.52 244.52 244.52 244.52 244.52 244.52	100 10 34433 800 4851 66498 1470 95653 3126 2850 3381 350 23701 400 23703 150 2411 150		0.50	10	34436.4174	5620.36345	1777.31498	30415.8516	38456.9832	24922.12	43609.13
1.50 10 31297.3250 3520.65418 1144.95138 28/07.2650 33887.3850 27388.51 xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	1.00 10 31247.3290 3620.65418 1141.45138 28707.2650 3387.3550 27355.51 1 le strength Total 40 33614.1366 5254.03111 830.73526 31933.8159 35294.4572 24717.90 1 le strength Table 68: Statistical analysis (one-way ANOVA) of WTS <i>Kalan square F</i> 0 0	1.00 10 37297.3250 3580.01338 28/07.2650 33887.3860 2738.51 1 1 10al 40 33614.1366 5254.03111 80.73526 31933.8159 3584.4572 24717.30 1 1 1 1 able 68: Statistical analysis (one-way ANOVA) of WTS 6 7 24717.30 1 1 1 1 able 68: Statistical analysis (one-way ANOVA) of WTS 6 7 0 <td< td=""><td></td><td>1.00</td><td>10</td><td>34453.8902</td><td>4651.66498</td><td>1470.98563</td><td>31126.2895</td><td>37781.4909</td><td>24717.90</td><td>40011.46</td></td<>		1.00	10	34453.8902	4651.66498	1470.98563	31126.2895	37781.4909	24717.90	40011.46
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properties to conventional dental stone.²³ Centers for Disease Control (CDC) cited chloramine-T as an alternative disinfectant to sodium hypochlorite.²⁴After going into all details, we preferred calcium hypochlorite to sodium hypochlorite to remain on the safer side, because the role of calcium hypochlorite (on alteration of strength) has never been disputed by any of the authors till now.

Twomy et al described in an identical manner. However, they did not explain the preference of bacteriophage phi29 over *Bacillus subtilis* species. We elaborated the microbiological and strength testing exclusively for a tropical country like India. However, most of the results were in agreement with them.²⁵

The limitations of this study were that, it was tested on a specific microbe presuming its behavior on others. The amount of available chlorine may also defer from manufacturer to manufacturer. Environmental effects like temperature and humidity may differ from one place to another. Again we were able to test only two properties of dental stone namely, compressive and tensile strength leaving aside all other physical properties. However, despite all these limitations, the result proves the disinfectant ability of calcium hypochlorite, specifically on dental stone.

CONCLUSION

The following conclusions were derived from the present study.

- 1. Calcium hypochlorite can act as a suitable disinfectant for type V dental stone, which may be helpful to dentists as well as laboratory personnel. To meet this requirements, it may be safer to choose the lowest concentration of calcium hypochlorite, i.e. 0.5% as a standard disinfectant for dental stone.
- 2. This disinfectant has no clinically significant adverse effect on tensile or compressive strength.

CLINICAL SIGNIFICANCE

Calcium hypochlorite can be an effective disinfectant in a dental laboratory set up with minimal adverse effect on the properties of type V dental stone.

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