RESEARCH ARTICLE

Effect of Different Chemical and Herbal Disinfectant Solutions on the Mechanical and Physical Properties of Gutta-percha: An *In Vitro* Study

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Abstract

Aim: To evaluate the effect of 5.25% sodium hypochlorite (SH), 90% aloe vera (AV) gel, and 2% chlorhexidine (CHX) as disinfecting solutions on the physical and mechanical properties of gutta-percha (GP).

Materials and methods: A total of 80 GP cones of size F3 ProTaper were obtained from sealed packet as four different groups. The experimental groups were disinfected with 5.25% SH, 90% AV gel, and 2% CHX except control group. The tensile strength of GP cones was measured under universal testing machine, and the surface texture was analyzed under stereomicroscope.

Results: Mean tensile strength in the order of lowest to highest was 9.13 for 5.25% SH, 13.05 for 2% CHX, 13.56 for 90% AV, and 16.44 for control group. The 5.25% SH group showed pitting on surface and control group and AV group showed negligible pitting, whereas 2% CHX showed moderate pitting on surface under stereomicroscope.

Conclusion: Aloe vera gel at 90% can be considered as a safer GP cone disinfectant.

Clinical significance: The main objective of root canal treatment depends on the elimination of microorganism from the root canal system. To obtain aseptic condition, disinfection of GP cone is required, which may get contaminated during handling. Aloe vera gel can be a promising herbal disinfecting solution for GP cone without affecting any physical and mechanical properties of it.

Keywords: Chlorhexidine, Root canal treatment, Stereomicroscope.

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Introduction

The main goal of root canal therapy is to provide complete disinfection and asepsis of root canal system right from access preparation till the postobturation restoration. Care is needed to prevent cross contamination of the root canal system with instruments and root canal filling material.[1] Most commonly used root canal filling material is gutta-percha (GP). Although GP cones come in presterilized package which might get contaminated by aerosols, improper storage, and handling. Various studies showed that *Staphylococcus* is found to be the most common microorganism contaminating GP cones in their boxes and during handling with gloves.[2] So, decontamination of GP is important. Although GP and sealer are antibacterial, the controversy exists whether sterilization process is necessary or not.

Due to thermoplastic characteristic of GP cones, they cannot be sterilized by the conventional process in which moist or dry heat is used because it may cause physical changes to GP. Therefore, a rapid chairside chemical disinfection is needed.[3] The chemicals which are used for disinfection of GP cones are polyvinyl pyrolidone iodine, glutaraldehyde, sodium hypochlorite (SH), hydrogen peroxide, chlorhexidine (CHX), quaternary of ammonium, and ethyl alcohol.[4] Besides chemical disinfectants, a safe and effective herbal disinfectant has also been tried. Among them aloe vera (AV) gel is found to be bacteriostatic against *Staphylococcus aureus*, *Streptococcus pyogenes*, and *Salmonella paratyphi* and effective medium in decontaminating GP cones.[5] The null hypothesis was that different disinfectant solutions do not affect the mechanical and physical properties of GP.

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The research study was done to evaluate the effect of 5.25% SH, 90% AV gel, and 2% CHX as disinfecting solutions on the physical and mechanical properties of GP.

Materials and Methods

A total of 80 GP cones of size F3 ProTaper GP (Dentsply, Ballaigues, Switzerland) were taken. The cones were opened under sterile conditions from sealed packet and divided into four groups.

In group I, 5.25% SH (Chloraxid, Cerkamed, Poland) was used as a disinfectant. In a clean petri dish, 5.25% of SH was taken and cones were placed for 5 minutes. The cones were individually and aseptically rinsed with sterile distilled water and were dried in sterile Petri dish containing filter paper pad.

Aloe vera pulp was collected and then dried in an oven at 80°C for 48 hours and then ethanol was added.[6,7] In group II, GP cones

were disinfected with AV gel for 5 minutes. In group III, GP cones were disinfected with 2% CHX (Zodenta, India) for 5 minutes. Group IV was not disinfected and was taken as a control group.

Tensile strength of GP cone was measured under universal testing machine (Hitech Machine, Mumbai). Each cone was standardized to 14 mm length by cutting the cone from the base, 2 mm from each side of the cone was inserted into either ends of the holders of universal testing machine, and load was applied at a crosshead speed of 1 mm/minute, until maximum tensile failure was obtained and values were recorded. Change in surface texture was seen under stereomicroscope (Olympus CX41) at 40× magnification. Data were analyzed statistically using one-way analysis of variance (ANOVA) to compare the differences and *post hoc* Tukey test for a multiple comparison.

Results

The results were considered statistically significant at $p < 0.05$ (Table 1). One-way ANOVA test showed mean tensile strength was more in control group (16.44) and less in SH group (9.13) at $p = 0.001$. Results showed that 5.25% SH would decrease tensile strength (9.13) of GP cones after disinfection, which had a significant difference from control group (16.44) and AV gel group (13.56). Chlorhexidine group showed mean value of 13.05 (Table 2). The pairwise comparison of *post hoc* Tukey test showed statistically significant result at $p < 0.05$.

Whereas under stereomicroscope, surface roughness and pitting was more with 5.25% SH (Fig. 1), moderate pitting with 2% CHX (Fig. 2) and negligible pitting with AV group (Fig. 3) and control group (Fig. 4) on surface of GP cone.

Table 1: Comparison of mean tensile strength values using one-way analysis of variance test

Groups	*n*	*Mean*	*Standard deviation*	*F value*	*p value*
SH	20	9.13	0.22	7825.628	0.001*
AV	20	13.56	0.16		
CHX	20	13.05	0.11		
Control	20	16.44	0.07		

*Significant at $p < 0.05$

Table 2: Pairwise comparisons using *post hoc* Tukey test

(I) groups	*(J) groups*	*Mean difference (I – J)*	*p value*
SH	AV	−4.42	0.001*
	CHX	−3.92	0.001*
	Control	−7.31	0.001*
AV	SH	4.42	0.001*
	CHX	0.51	0.001*
	Control	−2.88	0.001*
CHX	SH	3.92	0.001*
	AV	−0.51	0.001*
	Control	−3.39	0.001*
Control	SH	7.31	0.001*
	AV	2.88	0.001*
	CHX	3.39	0.001*

*Significant at $p < 0.05$

Discussion

The major objective of endodontic therapy is to provide an aseptic and sterile environment for the root canal system. Hence, decontamination of GP is considered to be an important step before obturation in endodontic practice.[5] As GP cones cannot be sterilized by conventional autoclaving because of the nature of GP cone, different chemicals have been suggested for use in decontamination of cones. A rapid chairside sterilization technique is a reliable method for these cones.[2] Initially, the following agents have been recommended: zephirin, zephirin chloride, untinted tincture of metaphen, thimerosal, povidone-iodine, alcohol, formaldehyde gas, and glutaraldehyde.[8] Therefore, this study was undertaken.

The result of this study showed that control group has greater mean tensile strength, i.e., 16.44, followed by AV group, i.e., 13.56, followed by 2% CHX group, i.e., 13.05, and least for 5.25% SH. Thus, the null hypothesis that different disinfectant solutions such as 5.25% SH, AV gel, and 2% CHX do not affect the mechanical and physical properties of GP cone was rejected.

The control group was not treated with any disinfectant and hence showed good tensile strength. In this study F3 ProTaper GP cones were selected as minimum apical preparation should be till 30 size.[5]

Aloe vera gel group showed comparatively better result than CHX and SH groups, which might be attributed to its antimicrobial property. This is in accordance with its antimicrobial property which has been implicated for the treatment of peptic ulcers and in cosmetics previously. Lawrence et al. stated that antimicrobial activity of AV is due to *p*-coumaric acid, ascorbic acid, pyrocatechol, and cinnamic acid.[9] Aloe vera gel is rich with variety of secondary metabolites, such as anthraquinone glycosides, glycoproteins, γ-lanoline acid, prostaglandins, and mucopolysaccharides, which are responsible for the antimicrobial activity.[10] The advantage of AV gel is that it can decontaminate the cone within 1 minute.[11] So, as per the study, AV could be a viable option for disinfection of GP cone.

Chlorhexidine solution at 2% is a cationic bisguanide that kills the bacteria by disruption of cell membrane and by inducing precipitation of cytoplasm. Chlorhexidine has additional properties such as substantivity and biocompatibility compared with NaOCl.[1] In this study, 2% CHX produces minimal superficial alteration on GP cones when observed under stereomicroscope, and the tensile

Fig. 1: 5.25% sodium hypochlorite

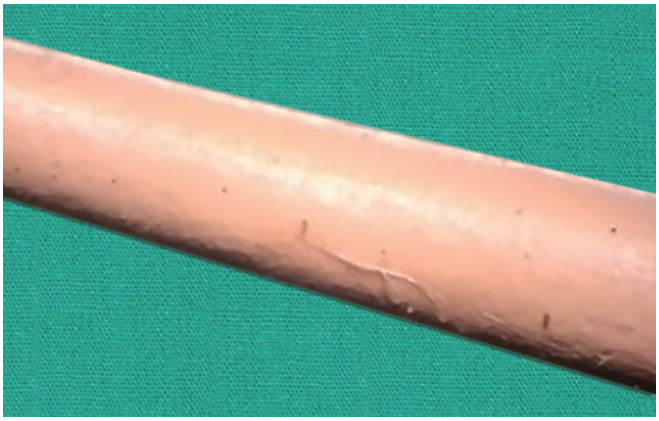

Fig. 2: 2% chlorhexidine

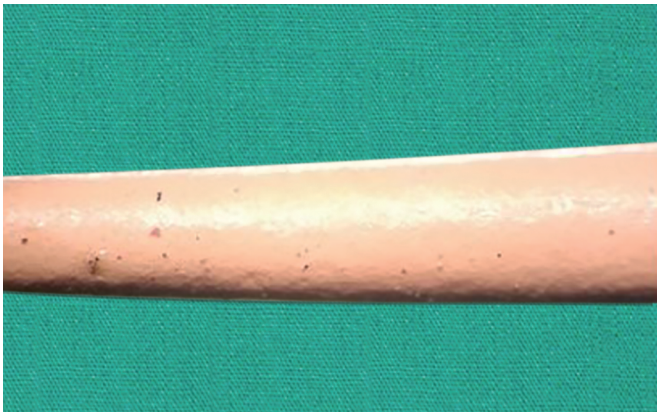

Fig. 3: 90% aloe vera gel

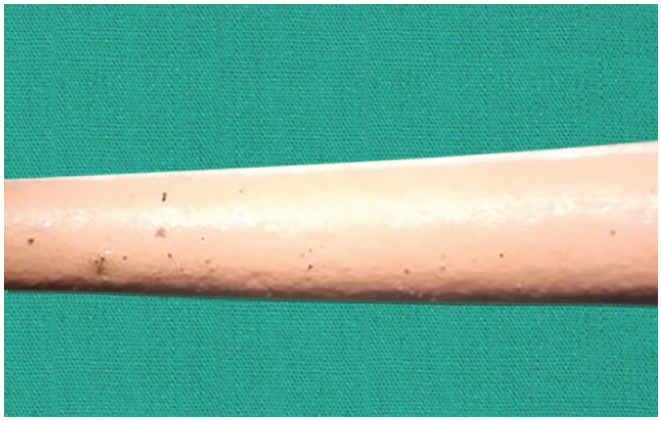

Fig. 4: Control group

strength was found to be greater than SH group but less than control and AV gel groups.

The most reliable and convenient technique for disinfecting GP cones is the rapid sterilization technique in which GP cones are placed into 5.25% NaOCl for at least 1 minute.[8,12]

Sodium hypochlorite has been found to be rapid and effective in disinfecting GP cones because of its strong antibacterial, sporicidal, and oxidizing activity.[5] In this study, the mean tensile strength was lowest for SH group, i.e., 9.13, at *p* value of 0.001. The result of this study is in accordance with studies done by Mahali et al., which revealed that the control group showed the highest tensile strength, irrespective of taper and size of the GP cones. Whereas there was a significant reduction in tensile strength of GP cones on disinfection with 5.25% NaOCl and pitting and irregularities seen under stereomicroscope.

Short et al. reported that the sodium chloride crystals were formed on the surface of SH-soaked GP cones at various concentrations and suggested that it may affect apical sealing at the time of canal filling.[1,8] Valois et al. reported that 5.25% SH had resulted in surface deterioration of GP cones which leads to surface irregularities and elasticity. Surface irregularities increase the risk of leakage due to large interfacial gap, and increase in elasticity leads to difficulty in obturating the curved canals.[12]

As studies have proven that 5.25% NaOCl may cause physical and mechanical alteration of GP cones during chairside disinfection.[13] The use of AV gel can be considered as an alternative to obtain an uncontaminated root canal system and good apical seal.

Conclusion

Aloe vera gel at 90% is considered as a safer GP disinfectant as it does not alter the tensile strength and topography of GP, which eventually will lead to enhanced sealing ability and reinforcement of the root canal.

Sodium hypochlorite solution at 5.25% would decrease the tensile strength and left a numerous pitting on the surface of GP cones.

Clinical Significance

The main objective of root canal treatment depends on the elimination of microorganism from the root canal system. To obtain aseptic condition, disinfection of GP cone is required, which may get contaminated during handling. Aloe vera gel can be a promising herbal disinfecting solution for GP cone without affecting any physical and mechanical properties of it.

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