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ORIGINAL ARTICLE

# Comparative evaluation of tensile strength of gutta-percha points after using different disinfectants and time durations - An *in vitro* study

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*Aloe vera*, calcium hypochlorite, disinfection, gutta-percha cones, hydrogen peroxide, sodium hypochlorite, tensile strength

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## Abstract

**Aim:** This study aims to evaluate and compare the tensile strength of gutta-percha points after disinfection with different types of disinfectants with different time durations.

**Materials and Methods:** Gutta-percha points of size 25, 6% taper were disinfected with 5.25% sodium hypochlorite, 5.25% calcium hypochlorite, 10% hydrogen peroxide, and *Aloe vera* gel for 20 s, 40 s, and 1 min separately except the control group. Tensile strengths of gutta-percha were measured using the computer control universal testing machine. The data were statistically analyzed using one-way (ANOVA).

**Results:** Results were subjected to statistical analysis one-way ANOVA and Tukey *post hoc* test. All these disinfectants solutions decreased the tensile strength of GP cones. Among the study groups, *A. vera* gel shows maximum reduction in tensile strength when used for 60 s as compare to 20 and 40 s duration.

**Conclusion:** Within the limitations of the study, it can be concluded that sodium hypochlorite, calcium hypochlorite, and hydrogen peroxide are safer disinfectants for the gutta-percha cones.

**Clinical Significance:** Gutta-percha disinfectants can affect the tensile strength of gutta-percha that may lead to change in the treatment outcome after root canal treatment.

## Introduction

The root canal obturation is the important step of endodontic treatment. There are various materials available for obturation, but gutta-percha is commonly used because it fulfills most of the criteria for ideal obturation material. According to infection control protocol, the instrument or material placed in root canal should be sterile.[1] Gutta-percha cones can get contaminated by aerosols, improper storage environment, and physical handling during or before obturation.[2]

Sterilization of gutta-percha cones is not possible by moist or dry heat because this may alter the structure of gutta-percha cones. Therefore, there is need of a rapid chairside chemical disinfectant for gutta-percha cones.[3]

There are various disinfectant chemicals available such as sodium hypochlorite, MTAD, chlorhexidine, hydrogen peroxide, and *Aloe vera* gel.

Sodium hypochlorite is a strong oxidizing agent that can cause extreme topographic alterations and aggressive deterioration in the gutta-percha cones, which results in decrease of adhesion or bond strength of gutta-percha cones to endodontic sealer. Moreover, there is decrease in tensile strength of gutta-percha points and cuboidal-shaped crystals formed on the surface of gutta-percha points with the use of sodium hypochlorite in 5.25% concentration, which could affect the sealing ability, reinforcement within the root canal, and prognosis of endodontic treatment.[4]

At present, no research exists that evaluate the effect of calcium hypochlorite on tensile strength of gutta-percha. Hence, the aim of this study was to evaluate and compare the effect of calcium hypochlorite on tensile strength of gutta-percha cones compared to other disinfectants. The objective of this study was to evaluate and compare the tensile strength of gutta-percha after disinfection with calcium hypochlorite with sodium hypochlorite, hydrogen peroxide, and *A. vera* gel and control group at different time intervals (20, 40, and 60 secs). The null hypothesis was that there was no significant difference in tensile strength of gutta-percha after disinfestation with calcium hypochlorite compared to other disinfectants.

## Materials and Methods

A total of 60 gutta-percha cones (DENTSPLY, Switzerland) of 25 number size, 6% taper were selected. The gutta-percha points were cut from base to make them standardized 18 mm length. Gutta-percha points then divided into five groups on the basis of disinfectants used ($n$ = 12).

- Group A –- Control group.
- Group B –- 5.25% sodium hypochlorite.
- Group C - 5.25% calcium hypochlorite.
- Group D - 10% hydrogen peroxide.
- Group E - Freshly extracted *A. vera* gel.

According to the duration of disinfection, Groups B, C, D, and E were subdivided into three subgroups.

- Group A - Gutta-percha cones were kept without disinfection (control group) [Figure 1a].
- Group B - Gutta-percha cones were disinfected with 5.25% NaOCl for 20 s (Group B1), 40 s (Group B2), and 1 min (Group B3), respectively [Figure 1b].
- Group C - Gutta-percha cones were disinfected with 5.25% calcium hypochlorite for 20 s (Group C1), 40 s (Group C2), and 1 min (Group C3), respectively [Figure 1c].
- Group D - Gutta-percha cones were disinfected with 10% hydrogen peroxide for 20 s (Group D1), 40 s (Group D2), and 1 min (Group D3), respectively [Figure 1d].
- Group E - Gutta-percha cones were disinfected with freshly extracted *A. vera* gel for 20 s (Group E1), 40 s (Group E2), and 1 min (Group E3), respectively [Figure 1e].

The tensile strength of all gutta-percha cones after disinfection was measured using computer controlled universal testing machine [Figure 2a].

About 2 mm from each side of the cone was inserted into either end of the holders of universal testing machine and load was applied at a crosshead speed of 1 mm/min, until maximum tensile failure was obtained and values were recorded.

The data were compared for differences using one-way analysis of variance followed by multiple comparisons using Bonferroni's *post hoc* test.

## Results

Results of this study revealed that all the disinfectants used decreased the tensile strength of gutta-percha points [Table 1 and Graph 1].

Among the study groups, *A. vera* gel showed maximum reduction in tensile strength when used for 60 s as compare to 20 and 40 s duration. *A. vera* gel decreased the tensile strength of gutta-percha cones in all the durations, which had a significant difference from the control Group A ($P \leq 0.05$) [Table 2 and Graph 2].

Intragroup tensile strength values in all the groups are not statistically significant [Table 3].

## Discussion

The significance of gutta-percha disinfection to prevent bacterial entry into root canal system is a widely accepted step in endodontics. Sodium hypochlorite at 5.25 concentration has been found to be rapid, reliable disinfectant of gutta-percha cones because of its strong antibacterial, oxidizing, and sporicidal activity.[6] *A. vera* gel has antimicrobial properties which is due to p-coumaric acid, ascorbic, and cinnamic acid.[7]

The gutta-percha is commonly used obturating material nowadays.

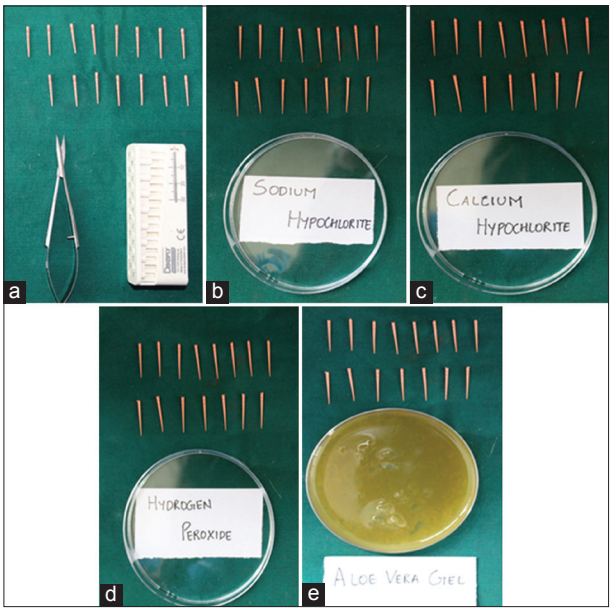



**Figure 1:** Disinfection procedure (a) Control group, (b) sodium hypochlorite, (c) calcium hypochlorite, (d) Hydrogen peroxide, (e) Aloe vera gel

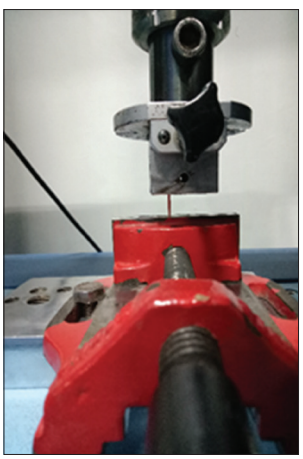
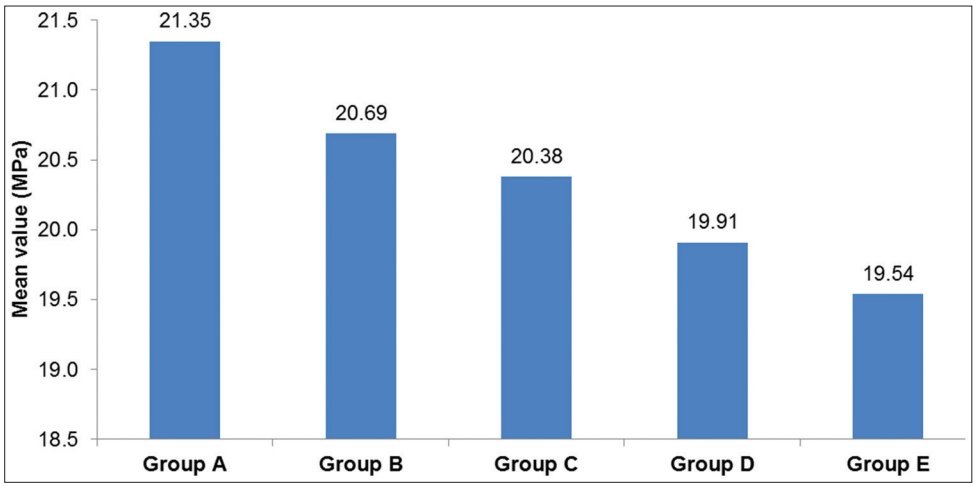


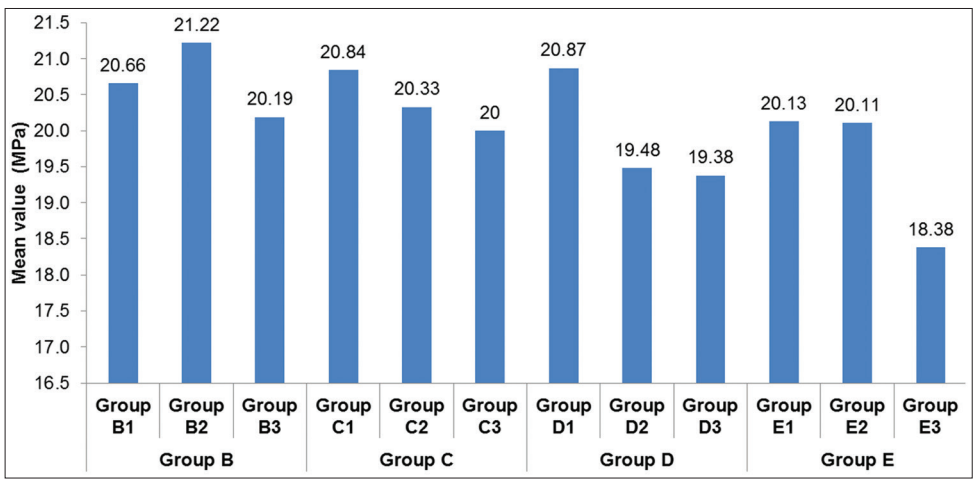
**Figure 2:** Evaluation of post disinfection tensile strength of gutta percha with universal testing machine

**Table 1:** Intergroup distribution of mean tensile strength

| Disinfectants groups | Group A ($n$=15) | Group B ($n$=15) | Group C ($n$=15) | Group D ($n$=15) | Group E ($n$=15) |
|---|---|---|---|---|---|
| | Mean±SD | Mean±SD | Mean±SD | Mean±SD | Mean±SD |
| Tensile strength(MPa) | 21.35±2.71 | 20.69±1.58 | 20.38±0.71 | 19.91±1.23 | 19.54±1.36 |




**Graph 1:** Intergroup distribution of mean tensile strength




**Graph 2: Intragroup distribution of mean tensile strength**

**Table 2:** Intergroup statistical comparison of mean tensile strength

| Disinfectants subgroups | Intergroup comparisons (*P*-values) | | | | |
|---|---|---|---|---|---|
| | Group A versus Group B | Group A versus Group C | Group A versus Group D | Group A versus Group E | Group B versus Group C |
| *P*-value | 0.999$^{NS}$ | 0.999$^{NS}$ | 0.199$^{NS}$ | 0.038* | 0.999$^{NS}$ |
| | Group B versus Group D | Group B versus Group E | Group C versus Group D | Group C versus Group E | Group D versus Group E |
| *P*-value | 0.999$^{NS}$ | 0.609$^{NS}$ | 0.999$^{NS}$ | 0.999$^{NS}$ | 0.999$^{NS}$ |

*P*-values by one-way analysis of variance with Bonferroni's *post hoc* test for multiple group comparisons. *P* value<0.05 is considered to be statistically significant. **P*-value<0.05, NS: Statistically Non-significant

The mechanical properties of gutta-percha cone were indicative of a partially crystalline polymeric material and found to obey the Hook's law.[8] Several studies demonstrated that tensile strength was correlated to gutta-percha component of gutta-percha cone while modulus of elasticity and percentage of elongation were determined to be related to zinc oxide component of GP cones, and flexibility of the cone affected by wax and resin components of GP cone.[9]

As Sodium hypochlorite is a strong oxidizing agent and a strong base (pH > 11). It causes degradation and hydrolysis of amino acid by forming the chloramine molecules. It has the ability to reduce the chemical stability of chain polymer, resin, and waxes of gutta-percha cones. Such, a chemical instability would adversely affect the mechanical properties of a gutta-percha cone and can cause negative effect on the bond strength between adhesive restorations and dentin. After disinfection, the

**Table 3:** Intragroup statistical comparison of mean tensile strength

| Group | Subgroup comparison | *P*-value |
|---|---|---|
| Group B (*n*=15) | B1 versus B2 | 0.999$^{NS}$ |
| | B1 versus B3 | 0.999$^{NS}$ |
| | B2 versus B3 | 0.999$^{NS}$ |
| Group C (*n*=15) | C1 versus C2 | 0.738$^{NS}$ |
| | C1 versus C3 | 0.200$^{NS}$ |
| | C2 versus C3 | 0.999$^{NS}$ |
| Group D (*n*=15) | D1 versus D2 | 0.201$^{NS}$ |
| | D1 versus D3 | 0.155$^{NS}$ |
| | D2 versus D3 | 0.999$^{NS}$ |
| Group E (*n*=15) | E1 versus E2 | 0.999$^{NS}$ |
| | E1 versus E3 | 0.100$^{N\Sigma}$ |
| | E2 versus E3 | 0.106$^{NS}$ |

gutta-percha cones should be washout in ethyl alcohol solution to eliminate sodium hypochlorite crystals before obturation because these crystals can lead to failure of hermetic seal.

Hence, all these adversely affect sealing ability and reinforcement in the root canal, which were the main causes of endodontic failure.

Calcium hypochlorite $Ca(OCl)_2$ is a relatively stable chemical substance that is commonly utilized for water purification and industrial sterilization. Some studies state that calcium hypochlorite solutions have higher concentration of active chlorine as compared to NaOCl with the exact similar concentration, in the same time duration and in the similar storage condition. Sodium hypochlorite and calcium hypochlorite belong to the same family and they are basically used as bleaching agents or disinfectants.[10] Hydrogen peroxide is a colorless chemical solution and has been used in dentistry in 1–30% concentrations. Hydrogen peroxide on degradation forms water and oxygen. The hydroxyl radical, being a potent oxidant, can react easily with macromolecules such as membrane lipids and DNA, thus resulting in bacterial death.[11]

*A. vera* plant is one of the richest natural sources of health for human beings coming. *A. vera* gel has bacteriostatic potential against *Streptococcus pyogenes, Staphylococcus aureus,* and *Salmonella paratyphi.* It is capable of decontaminating gutta-percha cones.[4] Natural anthraquinones are responsible for antimicrobial action of *A. vera*. In a study done by Suleyman *et al.,* Streptococcus faecalis and *Candida albicans,* both bacteria and yeast cultured and it consists of CFU $10^8$–$10^9$ mL/1 microorganism. A juice of *A. vera* acquired from the cold pressed leaves of the plant was utilized and the results showed the presence of significant 20 mm and 30 mm zones of inhibition of against both organisms.[7] In literature, studies are there those evaluated the antimicrobial efficacy of *A. vera* gel on various microorganisms. According to literature, *A. vera* gel has superior antibacterial efficacy as compared to sodium hypochlorite and chlorhexidine.[12]

Earlier study by Ismail *et al.* showed that there was a significant reduction in tensile strength of gutta-percha points after disinfection with sodium hypochlorite solution in 5.25% concentration. There was no significant difference in the tensile strength of GP cones in the control group (no disinfection) and tensile strength of GP cones disinfected with 90% *A. vera* gel.[6] Mahali *et al*. evaluated the tensile strength of gutta-percha points after treated with 5.25% sodium hypochlorite and 90% *A. vera* gel. He concluded that *A. vera* gel does not alter the tensile strength of gutta-percha points.[4]

In contrast with above studies, in this present study, the mean value of tensile strength of the experimental groups treated with *A. vera* gel was significantly decreased when compared with control group ($P < 0.05$), whereas with sodium hypochlorite, calcium hypochlorite, and hydrogen peroxide, the value was not significantly changed. According to Jyothsna *et al*., *A. vera* gel consists of certain acids such as salicylic acid and uric acid.[13] These acidic components in *A. vera* might be responsible for reduction if tensile strength of gutta-percha cones. There was no statistical difference between tensile strength values of the control group and sodium hypochlorite, calcium hypochlorite, and hydrogen peroxide group ($P > 0.05$). However, there was statistical difference in tensile strength values of gutta-percha cones disinfected with *A. vera* gel and other disinfectants ($P > 0.05$). Hence, the null hypothesis was rejected.

In this study, we only evaluated and compared the tensile strength of gutta-percha with disinfectants. Further studies are needed to be carried out to prove the effect of *A. vera* gel on gutta-percha cones.

## Conclusion

From this study, it was concluded that sodium hypochlorite, calcium hypochlorite, and hydrogen peroxide are safer disinfectants for the gutta-percha cones. Freshly extracted *A. vera* gel is not an ideal solution for gutta-percha disinfectant as it alters the tensile strength of gutta-percha.

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