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Original Research

The Effect Of Different Chemical And Herbal Disinfecting Solutions On The Surface Topography And Tensile Strength Of Gutta-Percha: An Invitro Study

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ABSTRACT:
Background: This study investigates the impact of different disinfection agents on the tensile strength and surface defects of gutta-percha (GP) cones used in endodontic procedures. **Methods:** Various disinfection agents, including 90% Aloe vera gel, 2% Tea tree oil, 2% Chlorhexidine, and 5.25% Sodium hypochlorite, were applied to GP cones. Tensile strength and surface defects were assessed and compared among the study groups using statistical analyses. **Results:** The control group exhibited the highest tensile strength (16.27±0.77), while 2% Tea tree oil resulted in the lowest tensile strength (8.67±0.63). One-way analysis of variance revealed a statistically significant difference between the groups. Tukey 's post hoc tests indicated significant differences among most pairwise comparisons, except for 2% Chlorhexidine and 90% Aloe vera gel. The highest number of defects was observed in the 2% Tea tree oil group, while the least defects occurred in the 90% Aloe vera gel group, with no defects in the control group. **Conclusion:** Aloe vera gel emerged as a promising disinfection agent for GP cones, preserving tensile strength and minimizing surface defects, making it a viable alternative to conventional chemical agents in endodontic practice.

Keywords: Aloe vera gel, Gutta-percha cones, Endodontics, Tensile strength, Surface defects.

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INTRODUCTION

The main goal of root canal therapy (RCT) is to completely clean and sanitize the area from access preparation to post-obturation repair. Enough efforts should be made during the RCT to remove germs from the root canals and prevent them from entering the root canal system. For best infection control, every piece of equipment and material utilized inside a root canal must be sterile.1 Gutta-percha is the most often used obturating material. Disinfection is not necessary, contrary to an old school of thought, because gutta percha cones (GP) are made in an aseptic atmosphere and may even be antibacterial.2 With limited knowledge of its chemical and mechanical qualities, dentists have been employing GP as an obturating material for more than a century.3 There was no sufficient knowledge before to 1918, when the first scientific investigation on the properties of GP about its application in dentistry was reported.4 However, contamination of gutta-percha due to handling, aerosols, or storage is a possibility.5There weren't many cultivable germs present when the container was opened. The therapeutic usage of the packages, however, leads to more bacterial "contamination of the" GP cones.6 Root canal instrumentation and irrigation-assisted debridement are followed by a filling process that typically uses non-sterile gutta-percha points, breaching the asepsis protocol. contamination can occur during root canal closure with gutta-percha cones. Prevention becomes difficult. The GP cannot be spontaneously sterilized with dry or moist heat.7 Absolute gutta-percha has a temperature range of 600 C to 1000 C with partial decomposition before melting. It is stiff at room temperature. As a hydrocarbon, it can be dissolved by solutions like chloroform, eucalyptol, benzene, xylene, carbon disulfide, and several organic oils. Gutta-percha changes significantly when exposed to the environment, such as degradative oxidation and readily brittleness.8 Rapid chair-side chemical disinfection is recommended to overcome this challenge. For cold sterilization, researchers advise using chemical solutions. From a few seconds to extended periods, various chemical agents come into touch with the gutta-percha that needs to be sterilized.7 Polyvinyl pyrrolidone iodine, glutaraldehyde, sodium hypochlorite (NaOCl), hydrogen peroxide, chlorhexidine (CHX), quaternary ammonium, and ethyl alcohol are the chemicals used to disinfect GP cones.9 Physical changes in GP cones have been noticed after sterilizing. The tensile strength of the guttapercha cone significantly diminished, indicating that the surface steriliser had an effect on the guttapercha cone's physical properties.10 Researchers have to explore for novel antibacterial components in herbs because the indiscriminate use of antimicrobial drugs had resulted in the development of numerous resistant microbe strains. In addition to chemical disinfectants, herbal disinfectants such as aloe vera, neem, propolis, tulasi, ginger, and garlic have also been tried; it has been found that these are bacteriostatic against common pathogens including S. aureus and Streptococcus. pyogenes, and Salmonella paratyphi, as well as to be a successful decontamination method for GP cones.11Since the beginning of civilization, medicinal herbs have been a fundamental part of human existence. They create the traditional medical systems of India. More than 80% of the world's population relies on plant-based products to meet their basic healthcare needs, per World Health Organization (WHO) reports from 2005.12 Due to the uncontrolled use of synthetic medications, the number of drug-resistant diseases that affect both humans and plants has lately surged. In terms of using chemicals and heat to disinfect gutta-percha cones (GP) prior to obturation, we appear to be at a crossroads. It was proposed that GP cones might be effectively cleaned prior to obturation using herbal gels of neem and aloe vera, which have well-established antibacterial capabilities.12 Short and succulent, aloe vera possesses potent antiviral, antibacterial, and antifungal properties.13Natural anthraquinones found in the plant have been recognized to have inherent antibacterial properties. Neem has long been known to have beneficial effects against bacteria, fungi, and viruses. It also has anti-inflammatory, antiseptic, astringent, and analgesic characteristics. Complementary and alternative medicine has become more and more popular in recent years. manufactured predominantly from tea tree oil, which is used for its antibacterial characteristics. Melaleuca alternifolia.15 This investigation was conducted in the absence of prior studies to ascertain the effects of Tea tree oil extract and Neem leaf extract on the mechanical and physical features of GPs. conducted utilizing the Universal Testing Machine (UTM) and Scanning Electron Microscope (SEM) to evaluate the effects of 5.25% SH, 2% CHX, 90% AV gel Extract, 1:10(w/v) Neem leaf Extract, and 2% Tea tree oil Extract on the tensile strength and surface properties of GP. The null hypothesis was that various disinfection treatments have no impact on the mechanical and physical characteristics of GP.

MATERIAL AND METHODS

Gutta percha cones in size F3 were chosen as a sample from Pro Taper (Dentsply) and were collected from sterile, unopened packets.

INCLUSION CRITERIA

The study only employed samples that were still within their use-by dates.2 ZGutta-percha cones were taken out of sterile, firmly sealed containers.3. Only unharmed and undamaged Gutta-percha cones were chosen for the investigation.

EXCLUSION CRITERIA

Damaged and deformed Cones made of gutta-percha were not used. Gutta-percha cones that were bent were not allowed. Expiring Gutta-percha cones were not included. Following approval from the Institutional Ethical Committee, this study was carried out in the Department of Conservative Dentistry and Endodontics at KIMS Dental College and Hospital, Amalapuram, using a total of 120 GP cones. The GP cones were taken out of their sterile, sealed containers. Based on the disinfectant used, the GP cones were randomly divided into six groups, each with 20 cones. Group 1: The disinfectant in Group 1 was 5.25% sodium hypochlorite (NaOCl). For five minutes, GP cones were submerged in 5.25% NaOCl in a clean petri dish. The cones were delicately extracted from the solution using sterile tweezers, then each one was cleaned with sterile distilled water before being dried on filter paper pads. Group 2: The disinfectant employed was % chlorhexidine (CHX). For five minutes, GP cones were placed in a sterile petri dish containing 2% CHX. The cones were extracted from the water after submersion using sterile tweezers, washed in sterile distilled water, and then dried on filter paper pads. Group 3: Using steam distillation, 90% of the Aloe vera gel extract (AV) was created. For five minutes, GP cones were inserted in a sterile petri dish with AV extract. The cones were extracted from the water after submersion using sterile tweezers, washed in sterile distilled water, and then dried on filter paper pads. Group 4: 1:10 (w/v) for Group 4 Alcohol was used to make neem leaf extract. For five minutes, GP cones were placed in a sterile petri dish with Neem leaf extract. The cones were extracted from the water after submersion using sterile tweezers, washed in sterile distilled water, and then dried on filter paper pads. Group 5: Steam distillation was used to create 2% Tea tree oil extract. GP cones were left in a 2% tea tree oil extract solution in a clean petri dish for 5 minutes. The cones were pulled out of the water using sterile tweezers, washed in sterile distilled water, and then dried on filter paper pads. Group 6 (Control Group): GP cones were obtained straight from pre-sterilized packaging without being cleaned. Each group's GP cones were then divided into two subgroups, each of which had ten GP cones, to assess their tensile strength and surface topography.

TENSILE STRENGTH ASSESSMENT

- A universal testing device was used to determine the tensile strength of each GP cone.
- A sterile GP cutter was used to standardize the length of each cone to 14 mm.
- The universal testing machine's holds were placed 2 mm from the cone's ends, and the load was applied at a crosshead speed of 1 mm per minute until maximum tensile failure occurred. The values were then recorded using the formula.

$$\sigma_{max}=P_{max}/A_0$$

EVALUATION OF SURFACE TOPOGRAPHY

Using a scanning electron microscope (SEM), surface texture changes were seen. The GP cones were examined after gold sputtering, mounted on aluminum studs, and treated in a vacuum chamber. The surface topography of each GP cone was investigated, and photos were taken at a 1000x magnification. A prior study's criteria were chosen to serve as the surface topography evaluation standards.

ANALYTICAL STATISTICS

Tensile strength testing was statistically analyzed using one-way analysis of variance (ANOVA) with Tukey's post hoc tests in IBM SPSS version 20. Data analysis for surface flaws employed chi-square testing. Statistics were deemed significant at a p-value of less than 0.05 level of significance. Data was presented using bar charts and percentage component bar charts

RESULTS

Table1 presents the descriptive statistics for tensile strength in the study groups. Highest tensile strength was noted in the control group (16.27±0.77) followed by 90 % Aloe vera gel (13.99±0.63), and the least tensile strength was observed in the cones treated with 2% Tea tree oil (8.67±0.63). Comparison of tensile strength between the study groups using one way analysis of variance showed a statistically significant difference between the groups(Table2). key'sposthoctests were done for multiple pairwise comparisons. It was observed that all pairwise comparisons were statistically significant except the difference between 2%chlorhexidineand90% Aloeveragel(Table3). Table 4 Represents comparison of defect count between the study groups using Chisquare test. Highest number of defects was noted in the 2% Tea tree oil group followedby5.25%sodiumhypochloriteandtheleastnumberofdefectswereobservedintheconestreatedwith90%Aloeveragelwiththecontrolgroupdemonstratingnodefects. Analyzing the study data for surface defects showed a statistically significant differencebetweenthegroups.

Table 1: Descriptive statistics for tensile strength in the study groups

Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
5.25% sodiumhypochlorite	10	9.815000	.4678141	.1479358	9.480346	10.149654	8.9400	10.5800
2%chlorhexidine	10	13.533000	.7259025	.2295505	13.013721	14.052279	12.4700	14.7200
90%Aloeveragel	10	13.995000	.6355444	.2009768	13.540359	14.449641	13.1900	14.8600
2%Teatreeoil	10	8.672000	.6347493	.2007254	8.217928	9.126072	7.1500	9.5200
1:10(w/v) Neemleafextract	10	12.562000	.5980115	.1891078	12.134208	12.989792	11.4400	13.5400
Control	10	16.272000	.7756689	.2452880	15.717120	16.826880	14.8200	17.5400

Table 2: Comparison of tensile strength between the study groups

Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		F value	P value
					Lower Bound	Upper Bound		
5.25% sodiumhypochlorite	10	9.815000	.4678141	.1479358	9.480346	10.149654	188.191	<0.001*
2%chlorhexidine	10	13.533000	.7259025	.2295505	13.013721	14.052279		
90%Aloeveragel	10	13.995000	.6355444	.2009768	13.540359	14.449641		
2%Teatreeoil	10	8.672000	.6347493	.2007254	8.217928	9.126072		

1:10(w/v) Neemlea fextract	10	12.562000	.5980115	.1891078	12.134208	12.989792		
Control	10	16.272000	.7756689	.2452880	15.717120	16.826880		

One way analysis of variance; p≤0.05 considered statistically significant; *denotes statistical significance

Table 3: Multiple pairwise comparisons for tensile strength between the study groups

Reference group	Comparison group	Mean Difference	Std. Error	P value	95% Confidence Interval	
					Lower Bound	Upper Bound
5.25% sodiumhypochlorite	2%chlorhexidine	-3.7180000*	.2893607	.000	-4.572910	-2.863090
	90%Aloeveragel	-4.1800000*	.2893607	.000	-5.034910	-3.325090
	2%Teatreeoil	1.1430000*	.2893607	.003	.288090	1.997910
	1:10(w/v)Neemleafextract	-2.7470000*	.2893607	.000	-3.601910	-1.892090
	Control	-6.4570000*	.2893607	.000	-7.311910	-5.602090
2%chlorhexidine	90%Aloeveragel	-.4620000	.2893607	.604	-1.316910	.392910
	2%Teatreeoil	4.8610000*	.2893607	.000	4.006090	5.715910
	1:10(w/v)Neemleafextract	.9710000*	.2893607	.017	.116090	1.825910
	Control	-2.7390000*	.2893607	.000	-3.593910	-1.884090
90%Aloeveragel	2%Teatreeoil	5.3230000*	.2893607	.000	4.468090	6.177910
	1:10(w/v)Neemleafextract	1.4330000*	.2893607	.000	.578090	2.287910
	Control	-2.2770000*	.2893607	.000	-3.131910	-1.422090
2%Teatreeoil	1:10(w/v)Neemleafextract	-3.8900000*	.2893607	.000	-4.744910	-3.035090
	Control	-7.6000000*	.2893607	.000	-8.454910	-6.745090
1:10(w/v)Neem leafextract	Control	-3.7100000*	.2893607	.000	-4.564910	-2.855090

Tukey'sposthoctests;*denotesstatisticalsignificance

Table 4: Comparison of surface changes between the study groups

Group	Non(%)	Mild n(%)	Moderate n(%)	Severe n(%)	Chi square value	P value
5.25%sodiumhypochlorite	0	0	4(40)	6(60)	103.32	<0.001*
2%chlorhexidine	0	5(50)	5(50)	0		
90%Aloeveragel	2(20)	8(80)	0	0		
2%Teatreeoil	0	0	2(20)	8(80)		
1:10(w/v) Neem leafextract	0	3(30)	7(70)	0		
Control	7(70)	3(30)	0	0		

Chisquaretest;p≤0.05consideredstatisticallysignificant;*denotesstatisticalsignificance

DISCUSSION

In this piece, we explore the crucial debate around asepsis in endodontic therapy, highlighting how crucial it is to provide an aseptic field for effective treatment. During endodontic treatments, asepsis, which is characterized by the absence of infection and the prevention of microbial contact, is essential for protecting the operative areas. Several strategies are used to achieve this goal, including the use of antiseptics and rubber dams, which are essential elements of infection control in the healthcare industry as a whole.16 The tooth pulp was historically recognized as a potential source of infection leading to dentoalveolar abscesses after Miller's 1890 discovery of microorganisms in pulp tissue. It is imperative to maintain an aseptic environment for the duration of endodontic treatment. At every stage of endodontic therapy, achieving the ultimate goal of microbial contamination eradication, or at the very least, mitigation, is of utmost importance.17-20 A number of crucial steps are included in the procedure, such as biomechanical preparation (BMP), disinfecting, and root canal filling. NiTi tools have helped BMP, but obstacles such anatomical complexity and germs that are hidden deep into dentinal tubules still need to be overcome. Therefore, to ensure the elimination of debris and reduce bacteria, efficient irrigation solutions and intracanal dressings are essential.1,3,17-25 Obturation must be done correctly to create a fluid-tight seal in order for endodontic therapy to be successful. The most popular obturation material is gutta-percha cones, which Edwin Truman first introduced in 1847. They have the benefits of being biocompatible, radiopaque, thermoplastic, and dimensionally stable. Sterilization is necessary because even sealed gutta-percha cones that have already been sterilized can get contaminated while being handled, stored, or used.11,9,10,21-27 Due to gutta-percha's thermoplastic characteristics, conventional sterilizing techniques like moist or dry heat are inappropriate. The most common disinfectant is sodium hypochlorite (Na OCl), and the fastest approach is chairside chemical disinfection. Despite its high concentration, NaO Cl's alkaline nature neutralizes mild acidity and prevents bacterial growth. The interaction of NaOCl with fatty and amino acids causes proteins to become denaturized and disrupts bacterial metabolism, which has an antibacterial effect. However, gutta-percha cones' mechanical characteristics and capacity for sealing can be impacted by surface changes brought on by high NaOCl concentrations.28-32 Another efficient antibacterial agent used in various stages of endodontic therapy is chlorhexidine (CHX), which is known as the gold standard of oral antiseptics. By attaching to microbial cell walls and triggering cell lysis, CHX has a bactericidal effect. In numerous investigations, it has shown comparable antibacterial activity to NaOCl. Herbal agents have become viable, safe alternatives to chemical agents for reducing the negative effects they have on gutta-percha cones. Aloe vera, neem leaf, and tea tree oil are examples of herbal extracts that have demonstrated potential for cleaning gutta-percha cones without significantly changing their surface or losing their mechanical properties.25-30 In this study, various herbal agents such as Aloe vera extract, Neem leaf extract and Tea tree oil extract are used for disinfection of GP and then their action on Surface topography and Mechanical properties of GP are evaluated. Aloe vera extract in a concentration of 90% is used in this study. Natural ingredients like aloe vera are supposed to be nontoxic and biodegradable. It has been discovered that aloe vera has antibacterial and antifungal properties. It is made up of E. camaldulensis essential oil, which is distinguished by its high concentration of 1,8-cineole and well-documented antimicrobial activity.31-35 According to reports, Streptococcus aureus, Klebsiella pneumonia, Streptococcus pyogenes, Pseudomonas aeruginosa, E. coli, and Helicobacter pyroli can all be effectively killed, significantly reduced, or completely prevented from growing when exposed to aloe vera gel's antimicrobial properties. Anthraquinones and saponins, which are found in whole leaves, are thought to have direct antibacterial properties, whereas polysaccharides have been linked to direct bacterial activity through the stimulation of phagocytic leucocytes to kill bacteria. A hydroxylated phenol known as pyrocatechol is toxic to microorganisms. "It is believed that" the location and quantity of hydroxyl groups on the phenol group are related to both their toxicity to microorganisms and the rise in hydroxylation. Proteins and cell membranes are denaturized by the phenolic group in aloe vera extracts. They function as disinfectants, are powerful "in the presence" of organic material, and continue to work for a very long time after application.63In this study, highest tensile strength was noted in the control group (16.27±0.77) followed by 90 % Aloe vera gel (13.99±0.63)followed by2% CHX (13.53±0.72) followed by 1:10(w/v) neem leaf extract (12.56±0.59) followed by 5.25% NaOCl(9.81±0.46)and the least tensile strength was observed in the cones treated with 2% Tea tree oil (8.67±0.63) when tested under Universal testing machine.21-30 According to the results from the evaluation of Surface topography using SEM, highest number of pitting were found in tea tree oil group followed by 5.25% NAOCL followed by 1: 10(w/v) neem leaf extract followed by 2% CHX and the least were found in 90 % Aloe vera gel group which were almost similar to that of" control group. Several studies demonstrated that tensile strength was correlated to GP component of GP 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 effected by wax and resin components of GP cone.30-37 We examined the effects of Aloe vera, Neem leaf, and Tea tree oil extracts on the surface topography and tensile strength of gutta-percha cones in this work. Despite having antibacterial and antifungal capabilities, aloe vera extract had little effect on tensile strength and surface flaws. Despite a minor decrease in tensile strength and surface imperfections, neem leaf extract, a strong antibacterial agent, also demonstrated encouraging outcomes. While useful as a cleaner, tea tree oil extract severely reduced tensile strength and produced surface flaws. The study also emphasized the drawbacks of using SEM to assess surface topography and suggested the potential advantages of more sophisticated methods like AFM.

CONCLUSION

Asepsis is essential for the success of endodontic therapy, to sum up. Obturation materials like gutta-percha cones must be cleaned using antiseptics, including herbal alternatives. Extracts from aloe vera and neem leaves have become safer alternatives with no effect on mechanical characteristics and surface topography. However, the particular clinical environment and the requirement for asepsis in endodontic procedures should be taken into account when choosing a disinfectant.

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