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Effect of Different Disinfectant Solutions on the Properties of Gutta Percha Cones

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Key words
disinfection, gutta percha, surface texture, mechanical properties.

Abstract

The purposes of this study was to investigate the effect of sodium hypochlorite (SH) and chlorhexidine (CH) disinfectant solusions on surface texture and mechanical properties of gutta percha (GP) cones at different concentrations and time intervals. In this study, 190 GP cones size 100 were used. SH solutions at (1%, 2.5%, 5.25%) and CH solutions at (1%, 1.5%, 2%) were used for GP cones disinfection by submerging cones for (10 min, 15 min, 20 min) in each of the solutions to be tested, in which 10 cones were used for each disinfectant solution at every time interval, and 10 cones remain fresh as a control. Surface texture determined by stereomicroscope. Mechanical properties measured by digital universal testing machine. SH solutions at (2.5% and 5.25%) decrease tensile strength, increase modulus of elasticity, decrease percentage of elongation , and left a numerous pitting on GP cones after (10, 15, 20) minutes of disinfection which were significantly different from fresh control cones, 1% SH , and CH at (1%, 1.5%, 2%).Within the limitations of this study, SH at 1% and CH at (1%, 1.5%, 2%) concentrations can be considered the most safe solutions for disinfection of GP cones.

Introduction

The purposes of endodontic treatment are to remove all necrotic and vital tissues and microorganisms from root canal system and obturate the canal space tightly to avoid microbial growth. In this context, the filling material should also be free from microorganisms to avoid canal contamination [(1)].GP is the most commonly used root canal core filling material. Several studies have been reported that GP cones taken directly from the manufacture sealed package harbored. Cultivable microorganisms were quite low at the time of opening of package; clinical use of packages increased the number of microorganisms contaminating the GP cones [(2)]. Current root canal obturation technique involves the use of several chemicals for GP cones disinfection. Among these chemicals, SH and CH with their antimicrobial action are the most effective disinfectants for GP cones [(3-5)]. Several studies revealed that the selection of an ideal disinfectant for GP cones are very important, because they found that this disinfectant may affect the mechanical properties and surface texture of GP cones, then these may affect final outcome of obturation [(6-10)]. This study confirmed to evaluate the effect of SH solutions at

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concentrations of (1%, 2.5%, 5.25%) and CH solutions at concentrations of (1%, 1.5%, 2%) when used for GP cones disinfection at different time intervals (10 min, 15 min, 20 min) on the surface texture and mechanical properties (tensile strength, modulus of elasticity, and percentage of elongation) of GP cones.

Materials and Methods

Disinfection Method:

A total of 190 GP cones size 100 (Dia-Dent, Netherlands, Korea) were used in this experimental study. Disinfectant solutions used were SH (FAS a commercial household bleach, 6.25% (w/v), Iraq) at concentrations of (1%, 2.5%, 5.25%) and CH (Hibitane, 5% (w/v), Zeneca Limited U.K) at concentrations of (1%, 1.5%,and 2%) which were used at different time intervals (10 min, 15 min, 20 min). Ten cones were selected for each tested solution at every time interval and ten remained fresh without disinfection (control). Cones disinfection made by immersion in Petri dishes contain 20 ml of one of the tested solution and kept for the time required. Then, cones transferred individually and rinsed in sterile distilled water for one minute, then allowed to dry in sterile Petri dishes containing sterile filter paper pads. GP cones for each examined solution at every time interval kept in sterile screw capped vial [3-5].

Surface Texture Determination:

All GP cones (disinfected and not disinfected) were viewed under stereomicroscope (Motic, Taiwan) at high magnification (40 X) from all sides and photographs were taken.

Mechanical Testing:

Mechanical properties including tensile strength, modulus of elasticity, and percentage of elongation were measured for each sample using computer controlled universal testing machine (TERCO, MT, 3037, Sweden). Every cone was standardize to 14 mm length by cutting the cone from the base, then 2 mm from each side of the cone was inserted inside special grip. Cone placed on the grip to avoid plastic deformation and slippage of the cone during testing. Then, the grips were fixed on the testing machine in which a sensor attached to its upper part in order to control the load applied to the GP cones from 1gm as shown in Figure (1). The length of the specimen 10 mm and cross sectional area 1.38 mm^2. Increases on tensile load applied on GP cones in gm and on length in mm at cross head speed 1mm/minute were reported by the computer connected to a testing machine until maximum tensile failure was obtained. After that, tensile strength, modulus of elasticity, and percentage of elongation were estimated from the data reported on the connected computer. All data calculated were converted to Mpa [6,11-13].

Results

Surface Texture:

SH at (2.5% and 5.25%) left a numerous pitting on the surface of GP cones after 10 min of disinfection. While, SH at 1% and CH at (1%, 1.5%, 2%) would not affect surface of cones even after 20 min of immersion, which were closely similar to freshly control cones as shown in Figure (2).

Mechanical Properties:

The data were compared for differences using one way analysis of variance, followed by multiple comparisons performed using a scheffé test. The results considered statistically significant at a $P \leq 0.05$. This was shown in Table (1) and (2).Results revealed that SH at (2.5% and 5.25%) would increase modulus of elasticity, decrease tensile strength, and decrease percentage of elongation of GP cones after (10, 15, 20) minute of disinfection, which had a significant difference from controlled cones and those submerged on 1% SH and (1%, 1.5%, 2%) CH at different time intervals. But, there were no significant differences on mechanical properties of cones disinfected either with 2.5% or 5.25% SH solutions. Results also showed that mechanical properties of GP cones immersed in CH at

(1%, 1.5%, 2%) or in SH at 1% after different time intervals nearly similar to those of freshly controlled cones. However, 1% SH group soaked had no significant difference from CH groups soaked. Results also determine that there were no significant differences among CH groups disinfected.Comparing results between different times (10, 15, 20) minutes for every disinfectant solution alone. Results found increase in the time of disinfection lead to increase in modulus of elasticity, decrease tensile strength, and decrease percentage of elongation of GP cones. But, significantly there were no differences among them.

Discussion

The success of endodontic treatment depends on ability to clean, shape, disinfect, and three dimensionally fill a root canal system [(7)]. GP cone is one of the most popular materials for obturating root canal space. Although GP cones are essential factor within the aseptic chain, often little attention is paid to the microbiological cleanliness of the cones selected prior to their use in filling the canal [(2-4)].As, root canal filling cones must remain in the root canal over a long period of time, and therefore they must be able to withstand rigorous sterilization procedures. Studies on the affects of disinfection on the mechanical properties and surface texture of GP cones have been reported [(6-10)], but they are limited and remain many unclear issues. The mechanical properties of GP cone were indicative of a partially crystalline polymeric material and found to obey to Hook's law [(12,13)].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 [(12,13)]. As, SH is known to be strong oxidizing agent and has the potential to reduce the chemical stability of chain polymer, resin, and waxes of GP cones. Such, a chemical instability would adversely affect the mechanical properties of a GP cone, with that danger in mind[(6-9)].Reduction on polymer component (GP component present on the composition of GP cone) of GP cone by SH at (2.5% and 5.25%) might lead to decrease in the resistance of cone to tensile tension, which cause decrease in tensile strength. At the same time, reduction on polymer chain made the main component of GP cone will be zinc oxide. As zinc oxide component was responsible for rigidity of the cone. So, this might increase the elasticity (increase rigidity) of the cone. Also, increase on the rigidity will lead to decrease on the elongation rate percentage of the cone.Because of, SH at high concentration above 2.5% would decrease tensile strength and increase elasticity (too much increase rigidity) of GP cones. Also, left a multiple pitting on the surface of GP cones which might decrease adhesion or bond strength of GP cones to endodontic sealer. So, all these thought to adversely affect sealing ability and reinforcement in the root canal. Which were the main causes of endodontic failure. It is found in this study that SH at 1% and CH at (1%,1.5%,2%) were the most safe solution for disinfection of GP cones, while SH at concentration higher than 2.5% would lead to the deterioration on the surface texture and mechanical properties of GP cones, and this was agreed with Valois *et al* .[(8)] ,Valois *et al*. [(9)] and Zamany [(7)], Pang *et al*. [(6)], and Short *et al*. [(10)]. Valois *et al* .[(8)] compare the effects of 2% CH and 5.25% SH on GP cone structure after 1, 5, 10, 20, 30 min of immersion. Result revealed that CH did not change GP cone structure following 30 min of exposure, but conversely 5.25% SH caused increase in elasticity after one minute of disinfection. Valois *et al*. [(9)] and Zamany [(7)] investigate the effects of SH solution at (0.5%, 2.5%, and 5.25%) on GP cones after 1 and 5 minute of disinfection. Results found that 2.5% and 5.25% SH caused increase on elasticity of GP cones after 5 minute of submersing, while 0.5% SH solution did not cause any alteration on GP cones. Pang *et al*. [(6)] evaluate effect of 5.25% of SH solution and 2% CH solution on tensile strength and surface

texture of GP cone. Results found that 5.25% of SH decreases tensile strength and left a cuboidal crystal on the surface of GP cone after one minute of immersion, conversely CH would not affect properties of GP cone.

Short *et al*. [10] identified the presence of crystallization on GP cones after rapid sterilization using 2.5% and 5.25% of SH solutions. They revealed that GP cones had sodium chlorite crystals after one minute of sterilization with 2.5% and 5.25% of SH solutions.

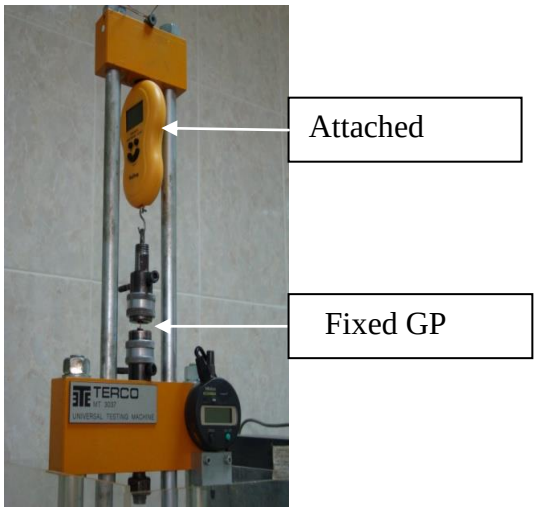

Fig.(1):- Sample fixed to the digital universal testing machine.

Conclusions

1-SH solutions at 2.5% and 5.25% would decrease tensile strength, increase modulus of elasticity, decrease percentage of elongation, and left a numerous pitting on the surface of GP cones. So, it must not to be used for GP disinfection.

2-SH solution at 1% and CH solution at (1%, 1.5%, 2%) could not effect mechanical properties and surface texture of GP even after 20 minute of disinfection. Therefore, they were considering as the safe disinfectant solutions for GP cones.

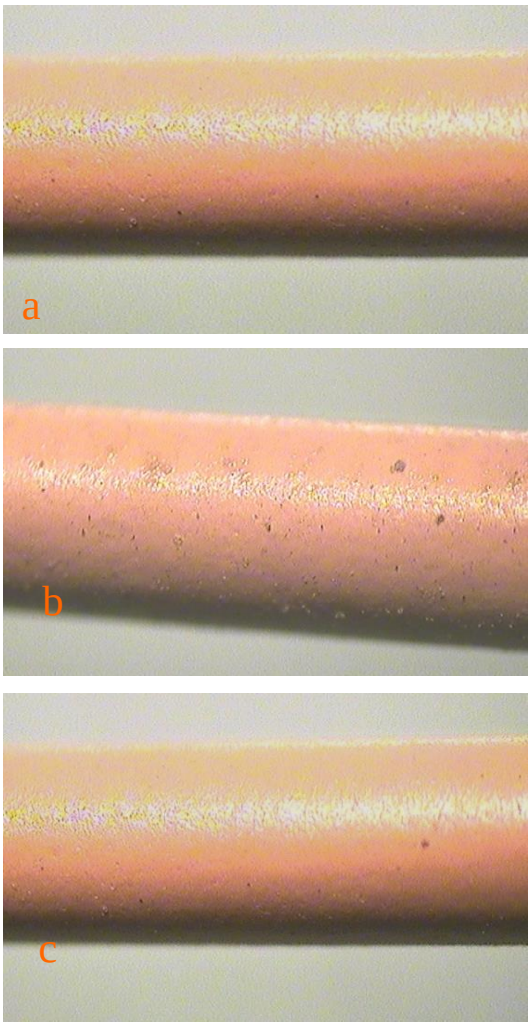

Fig.(2):-Surfaces of gutta percha cones disinfected and not disinfected.

a=surface of freshly control gutta percha cone.
b= surface of gutta percha cone disinfected with 2.5% sodium hypochlorite for 10 minute.
c= surface of gutta percha cone disinfected with 2% chlorhexidine for 20 minute.

Table (1)-: One way analysis of variance for the differences on mechanical properties of GP cones disinfected by different solutions.

		Sum of Squares	df	Mean Squares	Fc	Ft
ME[1]	Between Groups	187650.211	18	10425.012	178.377	1.609*
	Within Groups	9993.900	171	58.444		0.05
	Total	197644.111	189			(18,171)
TS[2]	Between Groups	1741.568	18	96.754	26.819	1.609*
	Within Groups	616.900	171	3.608		0.05
	Total	2358.468	189			(18,171)
EL[3]	Between Groups	167085.316	18	9282.518	295.451	1.609*
	Within Groups	5372.500	171	31.418		0.05
	Total	172457.826	189			(18,171)

[1]=Modulus of elasticity.[2]=Tensile strength.[3]=percentage of elongation. Fc=F calculated. Ft= F tabulated. *= significant difference.

Table (2):- scheffé test for the differences on mechanical properties of GP cones disinfected by different solutions.

Tested groups	Time intervals (minute)	Mean(Mpa)±SD		
		ME[1]	TS[2]	EL[3]
Control		71.7±3.77 A	10.8±1.93 A	108.8±3.39 A
*SH 1%	10	74.4±7.32 A	9.1±2.23 A	96.6±7.33 AB
	15	76.4±3.62 A	9.1±1.66 A	97.3±8.95 AB
	20	77.7±4.49 A	8.6±2.63 AB	93.2±8.95 AB
SH 2.5%	10	134.7±6.34 BC	6.9±0.73 C	46.7±10.34 C
	15	138±6.34 BC	6.7±0.67 C	44.1±8.72 C
	20	139±12.11 BC	6.2±0.87 C	43±9.82 C
SH 5.25%	10	139.2±9.26 C	6.1±0.86 C	38.1±5.21 C
	15	139.9±5.95 C	5.7±0.67 C	36.6±2.7 CD
	20	140.2±15.7 CD	5.6±0.51 C	36±3.02 CD
**CH 1%	10	72.1±5.36 A	10.1±2.4 A	108±3.82 A
	15	72.2±6.37 A	10±2 A	107.9±3.31 A
	20	72.3±5.71 A	9.9±2.51 A	107±3.05 A
CH 1.5%	10	73.2±4.8 A	9.8±2.6 A	107.6±4.06 A
	15	73.3±6.78 A	9.7±1.7 A	107.4±2.59 A
	20	73.4±3.33 A	9.6±1.76 A	107.2±0.30 A
CH 2%	10	74.2±6.86 A	9.5±3.02 A	107±4.05 A
	15	75.3±3.59 A	9.3±2.3 A	106.2±2.52 A
	20	77.7±4.49 A	9.2±1.687 A	106±3.82 A

The different letters vertically mean significant difference exist.[1]=Modulus of elasticity. [2]=Tensile strength. [3]=percentage of elongation.*=Sodium hypochlorite. **=Chlorhexidine.

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