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Evaluation of the pH Variation in Surrounding Medium Using Different Calcium Hydroxide Preparations As An Intra-Canal Medicament: An in-Vitro Study

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Abstract :
Aim*: To evaluate the pH variation in the surrounding medium after the use of two different vehicles of calcium hydroxide-saline(aq.),propylene glycol and calcium hydroxide points over a period of 7 days as an intra-canal medicament.*
Materials and Methods*: 40 extracted human premolars were decoronated and the canals were instrumented. A standardized external defects were prepared in the coronal third of the mesial surface of each tooth in order to simulate external root resorption. The samples were randomly divided into the 4 experimental groups (n = 10) according to the paste used for filling the root canals- Group I: The root canals were left empty and served as a control, Group II: The root canals were filled with a paste of calcium hydroxide powder and saline, Group III: The root canals were filled with a paste of calcium hydroxide powder and propylene glycol, Group IV: The root canals were filled with single calcium hydroxide point. After filling of canals, the coronal access was sealed with temporary filling material and all the surfaces of root except the defects were covered with nail varnish. Each sample was then placed in vials containing distilled water pH (7). The pH of each sample was measured after 1,3,5 and 7 days respectively. The pH was measured using a digital pH meter. Results were statistically analyzed using multiple ANOVA and Scheffe's post hoc test.*
Results*: Calcium hydroxide gutta-percha point group recorded highest pH and calcium hydroxide propylene glycol group recorded least pH among the experimental groups at the end of day 1. The maximum pH was recorded by the propylene glycol group and minimum by the calcium hydroxide points group and normal saline groups when recorded at the end of day 3 and 5. The pH of all the groups had decreased, with propylene glycol group recorded the maximum pH followed by normal saline group when recorded at the end of day 7.*
Conclusion*: Calcium hydroxide paste of propylene glycol (viscous vehicle) provided the sustained release of hydroxyl ions in the period of 7 days, which shows that the viscous vehicle is better among other vehicles.*
Keywords : *calcium hydroxide, calcium hydroxide points, external root resorption, intra-canal medicament, viscous vehicle.*

I. Introduction

Calcium hydroxide (CH) has been widely used in endodontics since its introduction by Hermann in 1920.[1] It is a strong alkaline substance, which has a pH of approximately 12.5.[1] Calcium hydroxide has been used in the treatment of root resorption, intracanal dressings for disinfecting the root canals and to promote periapical healing.[2]

It is stable for long period, biocompatible, and bactericidal.[3] CH induces necrosis of the resorptive cells on the root surface and the inactivation of lipopolysaccharide, a potent inducer of inflammation.[4] Calcium activates adenosine triphosphate, which is involved in cell migration, differentiation and mineralization.[5]

When used as an intracanal dressing, CH has been combined with different vehicles in order to provide a paste-like consistency.[6] Various substances such as water, saline, glycerine, propylene glycol and olive oil can be used as vehicles.[7]

The aqueous vehicle promotes a high degree of solubility and viscous water soluble vehicles may release ions slowly for an extended period of time. Oily vehicles that are insoluble in water provide the lowest solubility and diffusion of the calcium hydroxide.[8] Viscous vehicles are also water-soluble substances that release calcium ions more slowly and for extended periods. A viscous vehicle can remain within the root canal for a longer duration and hence the number of appointments required to change the dressing are reduced.[9]

The diffusion of calcium ions and hydroxyl ions from calcium hydroxide paste has been investigated by many researchers. The alkaline pH produced in the surrounding of peri-radicular region by the diffusion of hydroxyl ions is responsible for the antibacterial action of the calcium hydroxide intra-canal medicament.[8]

Hence, this in-vitro study was conducted to evaluate the pH variation due to diffusion of hydroxyl ions from calcium hydroxide mixed with two different vehicles (propylene glycol and normal saline) and calcium hydroxide gutta-percha points.

II. Materials And Method

Forty single rooted intact premolar teeth, without root resorption, free of caries, free of cracks, without previous restorations were included in the study and cleaned of debris and soft tissue remnant and stored in saline until use.

Preparation of samples for evaluation:

The teeth were decoronated at the cemento-enamel junction with abrasive discs in a high speed hand piece under a water spray and the root length was maintained between 12 to 15 mm. The working lengths of the root canals were determined by inserting a number 10 K-type file until it was seen at the apex and then subtracting 1mm from its length. The canals were instrumented by step back technique with K files till a master apical file size of 40 with constant irrigation of 5.25% sodium hypochlorite followed by 1ml of normal saline. In the coronal third of the mesial surface of each tooth, a standardized external defects of diameter 3 mm and 1 mm of depth were prepared with diamond points in order to simulate external root resorption. The teeth were radiographed to verify if the defect had not reached the root canal. The root canals of all the teeth were then dried with sterile paper points before placement of any medications. The CH was mixed using a ratio of 1gram of powder to 0.4mL of vehicle (propylene glycol / distilled water) to form a paste.

The samples were randomly divided into the following 1 control group (n=10) and 3 experimental groups (n = 10), according to the paste used for filling the root canals:

Group I: The root canals were left empty and served as a control.

Group II: The root canals were filled with a manually prepared paste of Calcium hydroxide powder and saline. A Lentulo Spiral was used to apply the paste followed by the use of hand pluggers to compact the material. Radiographs were taken to confirm the homogencity of the paste fill and absence of voids in the root canals.

Group III: The root canals were filled with a manually prepared paste of calcium hydroxide powder and propylene glycol. A Lentulo Spiral was used to apply the paste followed by the use of hand pluggers to compact the material. Radiographs were taken to confirm the homogencity of the paste fill and absence of voids in the root canals.

Group IV: The root canals were filled with single Calcium hydroxide point.

The coronal access was filled with 3 mm of temporary filling material Cavit G. All the surfaces of root except the defects were covered with three coats of Nail varnish. Each sample was then placed in airtight plastic vials containing 25ml of distilled water (pH-7). The samples were kept at room temperature throughout the observation period.

Ph Measurements

The pH was measured using a digital pH meter which was calibrated with standard pH solutions of pH 4,6 and 9. The test tip was washed with distilled water and dried with tissue paper to prevent any contamination between the tests.

An average of 3 readings was taken for one pH value. The pH of each sample was measured after 1,3,5 and 7 days respectively.

III. Statistical Analysis Used

Results were statistically analyzed using multiple ANOVA and Scheffe's post hoc test. All the statistical methods were carried out using SPSS(16.0) windows software. A statistically significant difference ($p<0.05$) existed between the experimental groups over the observation period.

Results

Calcium hydroxide gutta percha point group (Group IV) recorded highest value of pH 8.89 and calcium hydroxide propylene glycol group (Group III) recorded least pH value 8.47 among the experimental groups when pH recorded at the end of day 1.

The maximum pH was recorded by the propylene glycol group(Group III) and minimum by the calcium hydroxide points group (Group IV) and normal saline groups (Group II) when recorded at the end of day 3 and 5

The pH of all the groups had decreased, with propylene glycol group (Group III) recorded the maximum pH followed by normal saline group (Group II) when recorded at the end of day 7.

IV. Discussion

The intracanal medicaments has been a routinely use as an adjunct to endodontic treatment to control the bacterial contamination. These medicament eliminates the bacterias during inter appointmental period.[8]

Calcium hydroxide is commonly used intracanal medicament in endodontics. It has wide range of biological properties such as antibacterial activity, tissue dissolving ability, inhibition of tooth resorption and induction of repair by hard tissue formation.[2]

When used as an intracanal dressing, CH has been combined with different vehicles in order to provide a paste-like consistency.[6] Various substances such as water, saline, glycerine, propylene glycol and olive oil can be used as vehicles.[7]

In the present study two different vehicles of calcium hydroxide- saline (aq.), propylene glycol compared against calcium hydroxide points over a period of 7 days as an intracanal medicament.

An aqueous vehicle in the present study was - Saline, it was mixed with Calcium hydroxide powder manually to get a paste. The Calcium hydroxide has high solubility and high alkalinity in aqueous solutions like saline, ringer's solution and anesthetic solution.[10]

An viscous vehicle in the present study was – Propylene glycol, it was mixed with Calcium hydroxide powder manually to get a paste.

A viscous vehicle Propylene glycol, has strong antibacterial action. It is hygroscopic in nature and has high molecular weight (76.09) which makes it an ideal vehicle for pharmaceutical preparations and has no toxic effects on tissues. It has demonstrated a strong antibacterial action against common microorganisms found in infected root canals when used in concentrations upto 20%,[8,12] in the present study 10% propylene glycol was used.

The Calcium hydroxide points are specially prepared gutta percha points that contain Calcium hydroxide (52%). These points can be used as an intracanal medicament. It is claimed that these points overcome the drawbacks of conventional calcium hydroxide preparation such as poor handling properties and incomplete removal of calcium hydroxide suspensions. Therefore, this material was used in the present study.[13,14,15]

In the present study standard external defects measuring 3mm in diameter and 1mm in depth were prepared on the mesial surface in the coronal third of the roots in order to minimize the bias within the samples.[16,17,18] These defects provided uniform surface area of exposed dentinal tubules on the root for diffusion of the medicament.

In the present study the calcium hydroxide points showed the highest pH (8.89) at day 1. The high pH value of the calcium hydroxide points may be due to the increased amount of Calcium hydroxide – 51-52% in it's composition and the property of the material to diffuse in the surrounding environment of the root canal.[15]

In this study the calcium hydroxide points showed less pH than aqueous group at day 7 which is in agreement with the result of study conducted by Likoloas Economides et. al.[15] They evaluated the release of hydroxyl ions from Calcium hydroxide points and concluded that the calcium hydroxide points showed significantly lower alkalizing potential than non setting calcium hydroxide paste and calcium hydroxide mixed with distilled water (aqueous vehicle).

In the present study, saline group showed highest pH value next to calcium hydroxide points at day 1. The initial high pH in the saline group may be due to the ability of saline to promote a high degree of solubility of the Calcium hydroxide powder. Another reason for the initial rise of pH, and later drop may be due to the formation of insoluble calcium carbonate crust which blocks the dentinal tubules resulting in decrease in the pH and stabilization of ionic release.[19]

Camargo CHR, Bernardineli N et al evaluated the vehicle influence on calcium hydroxide pastes diffusion in human and bovine teeth, they concluded that the aqueous vehicle group (normal saline) showed initial rise and later drop of pH, which is in agreement with the present study. [20]

In the present study, maximum pH was recorded by the propylene glycol group(Group III) and minimum by the calcium hydroxide points group (Group IV) and normal saline groups (Group II) when recorded at the end of day 3 and 5.

These results of present study are in agreement with the study conducted by Suneeth Shetty and M.K.Manjunath et al, they evaluated the pH change through root dentin using different calcium hydroxide preparations as an intracanal medicament. In their study they concluded that, at day's 3 and 5, the maximum pH was recorded by the propylene glycol group and minimum by the calcium hydroxide points and saline groups. At day 7, the pH of all the groups had dropped, with propylene glycol recording the maximum pH followed by saline and lastly calcium hydroxide points.[21]

In the present study also pH of all the groups had decreased, with propylene glycol group (Group III) recorded the maximum pH followed by normal saline group(Group II) when recorded at the end of day 7.

The high pH of the propylene group may be attributed to its high molecular weight (76.09) hygroscopic nature and viscosity thereby having sustained release of ions.

Within the parameters of this in vitro study a calcium hydroxide paste with propylene glycol (viscous vehicle) remains the material of choice as a vehicle over calcium hydroxide points and aqueous (saline) calcium hydroxide paste.

Fig1: Measuring the length using Vernier caliper

Fig2: Decoronation of teeth

Fig3: Final prepared experimental sample

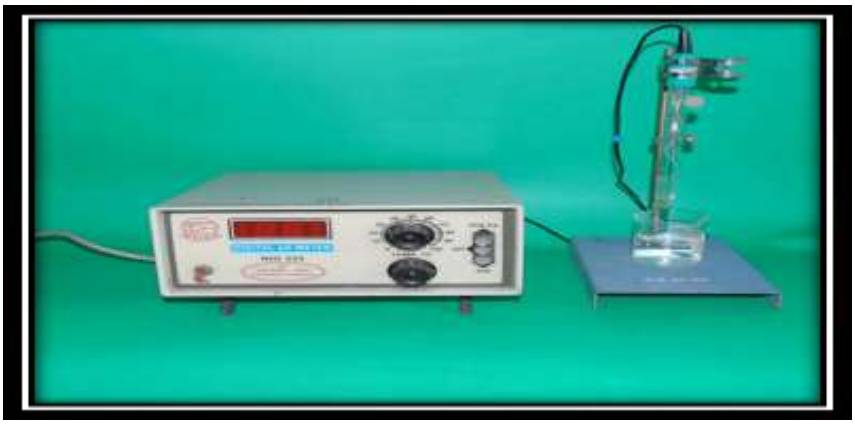

Fig4: Digital pH meter

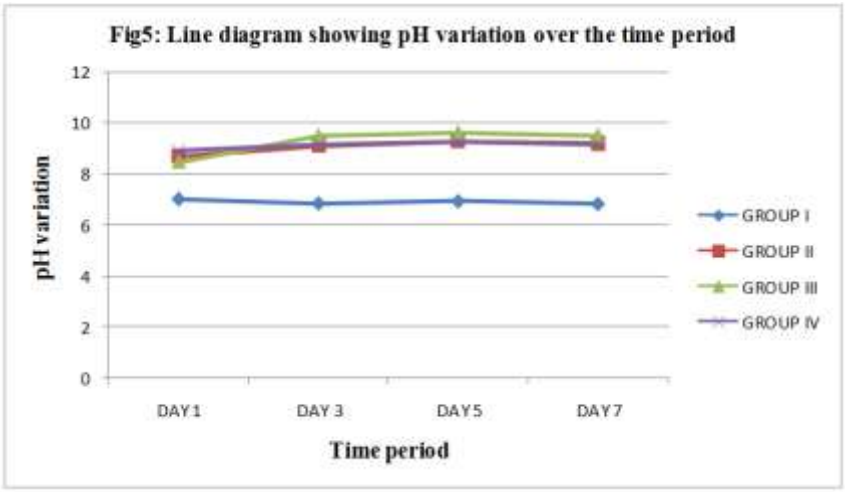

Table 1: Comparison of pH of groups at Day 1, Day 3, Day 5 & Day 7

(multiple ANOVA test)

	Group	Mean	SD	F-value	P-value
Day 1	**Group I**	**7.00**	**0.038**	**545.85**	**P=0.0000 S**
	Group II	**8.70**	**0.226**		
	Group III	**8.47**	**0.028**		
	Group IV	**8.89**	**0.031**		
Day 3	**Group I**	**6.99**	**0.17**	**98.84**	**P=0.0001 S**
	Group II	**9.12**	**0.21**		
	Group III	**9.49**	**0.58**		
	Group IV	**9.17**	**0.43**		
Day 5	**Group I**	**7.01**	**0.22**	**110.9**	**P=0.0001 S**
	Group II	**9.26**	**0.39**		
	Group III	**9.60**	**0.50**		
	Group IV	**9.28**	**0.311**		
Day 7	**Group I**	**7.01**	**0.039**	**144.4**	**P=0.0001 S**
	Group II	**9.18**	**0.24**		
	Group III	**9.50**	**0.45**		
	Group IV	**9.17**	**0.40**		

Table 2: Mean Difference of pH in Groups (Scheffe's Post-hock test)

	Groups	Mean Difference	P-value
Day 1	Group I Vs Group II	1.70	P=0.0000 S
	Group I Vs Group III	1.47	P=0.0000 S
	Group I Vs Group IV	1.89	P=0.0000 S
	Group II Vs Group III	0.23	P=0.001 S
	Group II Vs Group IV	0.19	P=0.008 S
	Group III Vs Group IV	0.42	P=0.0000 S
Day 3	Group I Vs Group II	2.13	P=0.0000 S
	Group I Vs Group III	2.50	P=0.0000 S
	Group I Vs Group IV	2.18	P=0.0000 S
	Group II Vs Group III	0.37	P=0.001 S
	Group II Vs Group IV	0.05	P=0.008 NS
	Group III Vs Group IV	0.421	P=0.0000 S
Day 5	Group I Vs Group II	2.25	P=0.0000 S
	Group I Vs Group III	2.59	P=0.0000 S
	Group I Vs Group IV	2.27	P=0.0000 S
	Group II Vs Group III	0.34	P=0.023 S
	Group II Vs Group IV	0.023	P=0.023 NS
	Group III Vs Group IV	0.3235	P=0.023 S
Day 7	Group I Vs Group II	2.172	P=0.0000 S
	Group I Vs Group III	2.491	P=0.0000 S
	Group I Vs Group IV	2.16	P=0.0000 S
	Group II Vs Group III	0.32	P=0.001 S
	Group II Vs Group IV	0.012	P=0.214NS
	Group III Vs Group IV	0.332	P=0.132 S

V. Conclusion

The conclusions drawn within the limitations of this in vitro study were-

- The diffusion of calcium ions had taken place from the intracanal environment to surrounding and hence alkaline pH was maintained by all the calcium hydroxide preparations used in the study.
- A high pH was recorded by the calcium hydroxide point groups and groups of normal saline and a lower pH by the propylene glycol group at the end of day 1.
- The maximum pH was recorded by the propylene glycol group and minimum by the calcium hydroxide point groups and normal saline groups at the end of day 3 and day 5.
- The pH of all the groups had decreased, with propylene glycol group recording the maximum pH followed by normal saline group and lastly calcium hydroxide point group at the end of day 7.

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