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Propylene Glycol: A New Alternative for an Intracanal Medicament

Siva Srinivas[1], N G Jibhkate[2], Rashmi Baranwal[3], Alok Avinash[4], Yogesh Tandil[5], Shravan Rathi[6]

Contributors:

[1]Professor and Head, Department of Conservative Dentistry and Endodontics, Amravati, Maharashtra, India; [2]Professor, Department of Conservative Dentistry and Endodontics, VYWS Dental College and Hospital, Amravati, Maharashtra, India; [3]Post Graduate Student, Department of Pedodontics and Preventive Dentistry, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh, India; [4]Reader, Department of Pedodontics and Preventive Dentistry, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh, India; [5]Reader, Department of Conservative Dentistry and Endodontics, VYWS Dental College and Hospital, Amravati, Maharashtra, India; [6]Senior Lecturer, Department of Conservative Dentistry and Endodontics, VYWS Dental College and Hospital, Amravati, Maharashtra, India.

Correspondence:

Dr. Baranwal R. Department of Pedodontics and Preventive Dentistry, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh, India. Phone: +91-9424600606. Email: rashmibarnwal@hotmail.com

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Abstract:

Background: For successful endodontic therapy, the most important factor is root canal cleaning. The difficulty involved in eliminating microorganisms, as well as their residual presence, after biomechanical preparation warrants the use of root canal dressings.

Materials and Methods: For this proposed study, single rooted extracted permanent tooth were selected. The teeth are randomly divided into two groups to fill the canals: Group I: Calcium hydroxide-propylene glycol paste. Group II: Calcium hydroxide-saline paste. After complete filing of the root canal, the pH values of the solutions in the flasks are measured at an interval of 3, 24, 72, and 168 h. Data obtained was entered into Microsoft Excel Spreadsheet and then transferred to SPSS version 16.0 Software for the statistical analysis.

Result: After 168 h interval, it was noticed that the mean pH obtained by calcium hydroxide - propylene glycol paste 9.70 ± 0.45 which was greater than calcium hydroxide - saline paste 9.16 ± 0.30 consecutively. Therefore, propylene glycol can also be used as a calcium hydroxide's vehicle.

Conclusion: The calcium hydroxide - propylene glycol paste was able to diffuse through the dentinal tubules. Thus, it can be used as a vehicle for calcium hydroxide.

Key Words: Calcium hydroxide, intracanal medicaments, propylene glycol

Introduction

Bacterial assault has been the most common etiology of dental pulp injury. There are various routes of the entrance of bacteria and bacterial products within the pulp.[1]

The principle aim in endodontics is elimination or reduction of microorganisms in the root canal system to achieve clinical success. Intracanal medicaments have been used as an adjunct in endodontics.[2] Of all the medicaments calcium hydroxide is the most preferred material for an intracanal dressing as it has got favorable antimicrobial action.[3]

Calcium hydroxide was introduced by Hermann in 1920. Now it is widely used in endodontics. It is a highly alkaline substance with a pH of 12.5. It has got a wide range of properties such as antimicrobial activity, inhibition of tooth resorption, and induction of repair by hard tissue formation.[4]

The success of calcium hydroxide paste as an intracanal medicament depends on its dissociation into calcium and hydroxyl ions. Due to the highly alkaline environment, most of the endodontic pathogens are unable to survive. The hydroxyl ions should remain in pulp and should be able to diffuse in dentin to improve its efficacy, so as produce the pH level required to destroy the bacteria within the root canal and dentinal tubules. The action of hydroxyl ions on tissues and bacteria are responsible for the biological and antimicrobial properties of calcium hydroxide.[5]

Aim and objectives of the study

The aim and objectives of this study are as follows:

1. To evaluate the diffusion ability of ions from a calcium hydroxide propylene glycol paste through dentinal tubules.
2. To compare the diffusion ability between calcium hydroxide - saline paste and calcium hydroxide - propylene glycol paste.

Materials and Methods

The present study was carried out in the Department of Pedodontics and Preventive Dentistry in association with Department of Microbiology, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh, India. The research protocol was reviewed and approved by the Institutional Ethical Committee, Ayush Health Science University, Chattisgarh.

For this proposed study, a total of 80 single rooted orthodontically extracted permanent tooth were selected. Single rooted orthodontically extracted permanent tooth were collected from the Department of Oral Surgery for the study. Tooth with resorbed root was excluded from the study.

The teeth were randomly selected and divided into two groups of 40 each:

Group I ($n = 40$): Calcium hydroxide-propylene glycol paste (prepared by mixing 1 g of calcium hydroxide and 2 ml of propylene glycol).
Group II ($n = 40$): Calcium hydroxide-saline paste (prepared by mixing 1 g of calcium hydroxide and 1.5 ml of saline solution).

The prospective investigation was a randomized controlled trial study with an experimental period of 7 days. Initially, 80 extracted teeth were kept in a 10% formaldehyde solution. Then after, with the help of dental scalers the soft tissues and dental calculus that remained adhered to the root were removed, after which the tooth was stored in saline solution. Then, the crowns were transversally sectioned with the carborundum disc at the cementoenamel junction level. Rubber stop was used to measure root canal length. The stop was leveled to the cervical edge when the file tip reached the apical foramen of the root, and the canal length was recorded. By subtracting one millimeter from the total root canal length, the working length was established. Preparation of apical area was performed up to this limit, up to file #80, followed by a step back instrumentation up to file no 120. Throughout the instrumentation procedure, the root canals were irrigated with distilled water.

The root canal was then filled with an EDTA solution for 3 min, after instrumentation by a no. 30 file, which was inserted to the total working length for apical cleaning. After this procedure, the root canals were rinsed with the help of saline solution and dried with the help of absorbent paper points. Then, the teeth were randomly divided into two groups.

After completing, the procedure filling of the root canals was done and their openings were sealed with temporary cement. The apical foramen and root canal opening were sealed with epoxy cement. Next, the teeth were placed in containers with 100% humidity in 50 ml of deionized water (pH = 6.17) and kept in an oven at 37°C. After time period of 3, 24, 72, and 168 h, the pH values of the solutions in the flasks were measured with a pH meter.

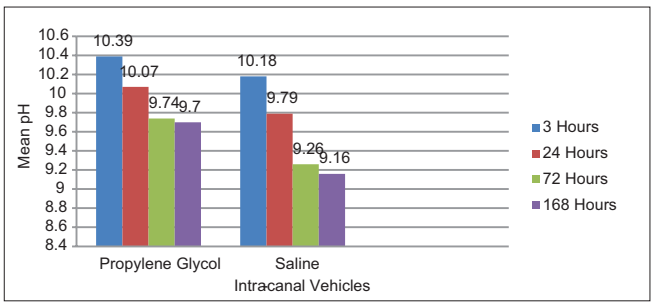
Statistical analysis

Data obtained was entered into Microsoft Excel Spreadsheet and then transferred to SPSS (Statistical Package for Social Sciences) version 16.0 Statistical Analysis Software for the statistical analysis.

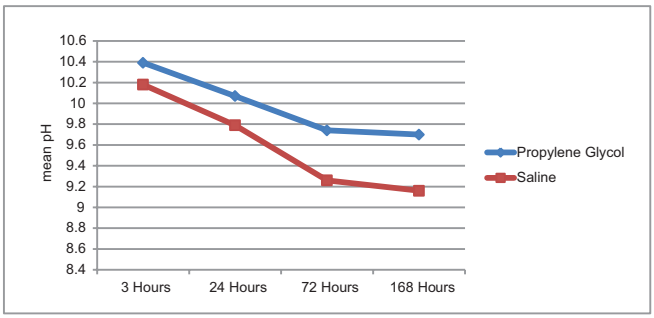
Results

The pH values were recorded and were evaluated using one-way ANOVA followed by *post-hoc* Turkey's HSD test.

Post-intervention comparison of the groups after 3, 24, 72, and 168 h showed significant variation in all the two groups ($P < 0.05$) (Graphs 1 and 2).



Graph 1: pH variation according to various study groups.



Graph 2: pH variation according to time interval.

Discussion

Endodontics has undergone a revolutionary change. The major goal of successful endodontic treatment is the elimination of the bacteria from the root canal space.

The outcome of endodontic therapy depends on the reduction or elimination of bacteria. Chemomechanical preparation may be considered an essential step in the root canal disinfection. However, total elimination of bacteria is difficult to accomplish. Thus, by remaining within the root canal, intracanal medicaments helps to eliminate surviving bacteria.[6]

The use of medicaments has been a routine practice for many years. In the past numerous, antimicrobial agents have been introduced as root canal medicaments.

Since the introduction of calcium hydroxide for use in dentistry by Herman in 1920, this medicament has been reported to promote healing. It is a white odorless powder. It has got wide range of properties which include antibacterial activity, tissue dissolving ability, and induction of repair by hard tissue formation. The main benefit, i.e. the antibacterial property is acquired by its high pH which is 12.5.[7]

Among all the intracanal medicaments, calcium hydroxide was the most commonly used due to its alkaline nature. It was shown to be highly effective over the persistent root canal flora when canals were dressed for 7 days.[8] Due to its superior activity and reduced cytotoxicity, it has been considered as the material of choice. The hydroxyl ions produced due to its dissociation in aqueous fluids are believed to be responsible for alkaline nature that is bactericidal. These hydroxyl ions induce lipid

peroxidation which helps in the destruction of phospholipids. The alkalinization causes destruction of the ionic bonds that forms the tertiary structure of proteins. They also react with bacterial DNA and induce splitting of the strands.[9]

The delivery of calcium hydroxide powder is alone is difficult or impossible so it must be mixed with a liquid to facilitate its placement within the canal.[1]

Calcium hydroxide when mixed with different vehicles has shown the potential to release calcium and hydroxyl ions through cementum.[7] The rate of dissociation into ions and diffusion through dentinal tubules is determined by the vehicles used. Thus, vehicles play an important role in the ionic dissociation.[5]

Lage Marques *et al.* concluded that aqueous and viscous vehicles when mixed with calcium hydroxide seems to be more effective as compared to oily vehicles because aqueous and viscous vehicles reach higher pH at a faster rate, and they remain stable for a longer period of time.[10]

Thus, calcium hydroxide must be associated to a vehicle for its use as an intracanal medicament.

Hence, the present study aimed at to evaluate the diffusion ability of ions from calcium hydroxide - propylene glycol paste through dentinal tubules and to compare the diffusion ability between calcium hydroxide - saline paste and calcium hydroxide - propylene glycol paste.

Propylene glycol (1,2-propanediol), is a dihydric alcohol. It was suggested by Laws in 1962 for its possible use as a vehicle in endodontics.[11,12] Propylene glycol is a colorless liquid with mild acrid smell and sweet taste. Olitzky (1965) stated that concentrated solution of propylene glycol showed marked germicidal efficiency. Hence, it can be used as a vehicle as it has the potential for preventing and treating microbial infections.[13] Bhat and Walkevar, Thomas *et al*. stated that as compared to other commonly used vehicles for intracanal medicaments propylene glycol has been found to be less cytotoxic and also possess antibacterial properties that are highly beneficial in the endodontic treatment.[11,14] Fava and Saunders said that propylene glycol possesses hygroscopic properties which allow absorption of water. This resulted in a sustained release of the intracanal medicament for prolonged period of time.[15]

For this study, single rooted orthodontically extracted permanent teeth were selected and the experiment was carried out. Based on the experiment, it was concluded that propylene glycol can be used as a vehicle for calcium hydroxide as it possess the ability to diffuse through dentinal tubules. It may be a better indication as compared to other intracanal vehicle as it adds to the antimicrobial action of calcium hydroxide.

Propylene glycol showed the ability to diffuse through dentinal tubules. When the pH variation was compared to saline then it was seen that calcium hydroxide propylene glycol paste provided a higher amount of hydroxyl ion release as compared to saline.

Cruz *et al*. evaluated and compared the penetration of propylene glycol and distilled water into root dentine and concluded that propylene glycol allowed dye to exit faster through the apical foramen. The area and depth of dye penetration with propylene glycol was significantly greater than with distilled water. They stated that the high surface tension of distilled water may have delayed the penetration through dentinal tubules while in case of propylene glycol already it is viscous as compared to distilled water but has got low surface tension so this gives the advantage of being penetrable through dentinal tubules.[16]

Chua *et al*. investigated the antifungal activity at two different depths (200 μm and 400 μm) and two time intervals (day 1 and 7) of propolis, triple antibiotic paste (TAP), 2% chlorhexidine gel, and calcium hydroxide with propylene glycol on *Candida albicans* - infected root canal dentinal tubules. They concluded that less effectiveness of propolis than TAP, 2% chlorhexidine gel and calcium hydroxide with propylene glycol against *C. albicans* on day 1 at 400 μm deep inside the dentinal tubules, but it was equally effective after 7 days at both depths.[17]

After 168 h interval, it was noticed that the mean pH obtained by calcium hydroxide - propylene glycol paste 9.70 (±0.45) and was greater than calcium hydroxide - saline paste 9.16 ± 0.30 consecutively. Hence, it was proven that calcium hydroxide propylene glycol paste has better diffusion ability as compared to calcium hydroxide saline paste. Therefore, propylene glycol can also be used as a vehicle for calcium hydroxide.

However, further *in vivo* and *in vitro* studies are required to investigate the biocompatibility of this paste and thus can confirm the further use of propylene glycol as a vehicle for calcium hydroxide.

Conclusion

The calcium hydroxide - propylene glycol paste used during the study was able to diffuse through the dentinal tubules. Thus, it can be used as a vehicle for calcium hydroxide.

After 168 h both the experimental group showed the ability of diffusion in the dentin and also showed the potential to alkalize the external root surface.

Thus, the clinical significance of using propylene glycol is that it possesses strong antibacterial action. Along with this, it also possesses hygroscopic nature and viscosity which results in the sustained release of ions. It also has no toxic effects on tissues.

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