ISSN- O: 2458 - 868X, ISSN –P: 2458 - 8687

International Journal of Medical Science and Innovative Research (IJMSIR)

IJMSIR : A Medical Publication Hub

Available Online at: www.ijmsir.com

Volume – 2, Issue –5, September- October - 2017, Page No. : 165 - 176

Sustained Release of Calcium Ions &Ph Maintenance from Different Vehicles containing calcium hydroxide- an in vitro study

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Conflicts of Interest: Nil

Abstract

AIM: The aim of the in vitro study is to determine the Sustained Release of Calcium Ions & pH maintenance from different vehicles containing calcium hydroxide using ultraviolet spectrophotometer and pH meter.

Material And Methods: The present in vitro study was carried out in Rajah Muthiah Dental College & Hospital, Annamalai University. Thirtysingle rooted human teeth extracted for orthodontic purpose or periodontal purpose were selected to determine the sustained release of calcium ions and pH maintenance from different vehicles containing calcium hydroxide using ultraviolet spectrophotometer and pH meter.The three types of vehicles which were mixed with calcium hydroxide are; An aqueous vehicle (anesthetic solution), viscous vehicle (propylene glycol) and an oily vehicle (olive oil).

Results: The results of the study concluded that Olive oil when used as a vehicle exhibited a sustained release of calcium ions from calcium hydroxide for prolonged duration when compared with propylene glycol and anesthetic solution.

Conclusion: Calcium hydroxide is the commonly preferred intracanal dressing in endodontics, its therapeutic effect mainly depends on its dissociation into calcium and hydroxyl ions, which in turn depends on the vehicles used.

Keywords: Calcium hydroxide, ultraviolet spectrophotometer, calcium ions, intracanal dressing, sustained release.

Introduction:

Root canal infections are polymicrobial infections characterized by mostly anaerobic bacteria and some facultative bacteria. A tooth with an infected necrotic pulp becomes a reservoir of infection isolated from the patient's immune response. Eventually, bacteria and bacterial by-products will produce a periradicular inflammatory response. With microbial invasion of periradicular tissues, an abscess or cellulitis may develop. The inflammatory response may give rise to both protective and immunopathogenic effects; it may also be destructive to surrounding tissue and contribute to adverse signs and symptoms. Severe infections may develop depending on the pathogenicity of the microorganisms involved and the resistance of the host.[1]

The spread of infection and the inflammatory response will continue until the source of the irritation is

removed.Successful management of the infected root canal system requires chemomechanical debridement of the root canal system. The objectives for endodontic treatment are removal of the microbes, their by-products and pulpal debris from the infected root canal system. This establishes a favorable condition for periradicular inflammation to resolve.[1]

Bacteria remaining in the apical part of the root canal have been suggested as a cause of failure, despite the fact that no bacteria could be detected in the canal before filling and after the use of an inter appointment dressing.[2] Cleaning and shaping of the root canal reduce the bacterial population but do not completely eliminate them. One possible reason for persistent endodontic infection might be due to the retention of microorganisms in the dentinal tubules of the root canal. Hence, the use of an intracanal medicament helps in the elimination of bacteria that remain even after cleaning and shaping, thereby providing an environment conductive for periapical tissue repair.[3]Calcium hydroxide ($Ca(OH)_2$) is one of the main root canal dressings used in endodontics since Hermann introduced it to dentistry in 1920. Moreover, it is biocompatible, has antimicrobial and anti-inflammatory action, and activates the alkaline phosphatase enzyme, which induces mineralized tissue formation and acts in the repair process. It is chemically classified as a strong base, and its association with an adequate vehicle yields an alkaline paste.[4] Calcium hydroxide has antibacterial action, tissue dissolving property, repairing ability and its capacity to induce hard tissue formation makes it widely used as an interappointment dressing. Dissociation of calcium into Ca^{2+} and OH^- leads to high pH and activation of alkaline phosphatase, which are responsible for its actions.[5]High pH of calcium hydroxide inhibits the enzyme activities that are essential to bacterial life, i.e., metabolism, growth and cellular division. The effect of pH on the transport of nutrients and organic components through the cytoplasmic membrane determines its toxic action on bacteria. This also activates the hydrolytic enzyme alkaline phosphatase, which is closely related to the process of tissue mineralization. Thus, this medication presents two fundamental enzyme properties: the inhibition of bacterial enzymes leading to an antimicrobial effect and the activation of tissue enzymes such as alkaline phosphatase leading to a mineralizing effect,[6]

The mechanisms that $Ca(OH)_2$ uses to eliminate bacteria may include damage to the bacterial cytoplasmic membrane by inducing lipid peroxidation, protein denaturation, damage to bacterial DNA and by serving as a physical barrier that withholds nutrients for bacterial growth and limits space for bacterial multiplication.[7]

For calcium hydroxide to act effectively as an intra canal dressing to prevent external resorption, hydroxyl ions must be able to diffuse through the dentin[.[8] Calcium hydroxide diffuses from the root canal to the exterior surface of the root and that removal of the intra canal smear layer may facilitate this diffusion.[9]. Several liquids have been added to calcium hydroxide powder to create pastes. This addition aims to facilitate the use of calcium hydroxide and improve its antimicrobial capacity, radiopacity and consistence. The vehicle employed in this association should allow gradual and efficient dissociation of hydroxyl ions for an efficient action of calcium hydroxide. The level of dissociation of calcium hydroxide into calcium and hydroxyl ions depends on the vehicle employed to prepare the paste. Besides allowing dissociation of the calcium hydroxide, the vehicle may increase the antimicrobialcapacity of the paste.[10]The vehicle used with $Ca(OH)_2$ to create a paste grant chemical characteristics that will influence its clinical handling during application and rate of ionic dissociation and diffusion. The hydrosoluble vehicles have better

biological behavior (antimicrobial qualities and induction of tissue repair), due to a higher ionic dissociation, whereas the use of viscous or oily vehicles have alkaline properties which will exhaust only after a longer period.[11]

The vehicles mixed with $Ca(OH)_2$ powder play an important role in the overall dissociation process because they determine the velocity of ionic dissociation causing the paste to be solubilized and resorbed at various rates by the periapical tissues and from within the root canal. The lower the viscosity, the higher will be the ionic dissociation. The high molecular weight of common vehicles minimizes the dispersion of $Ca(OH)_2$ into the tissues and maintains the paste in the desired area for longer periods of time.[12]An ideal vehicle should have certain properties like it should allow a gradual and slow Ca^{2+} and OH^- ionic release, allow slow diffusion in the tissues with low solubility in tissue fluids, it should have no adverse effect on the induction of hard tissue deposition.[13]The type of vehicle has a direct relationship with the concentration and the velocity of ionic liberation as well as with the antibacterial action when the paste is carried into a contaminated area. The differences in the velocity of ionic dissociation are related directly to the vehicle employed to obtain the paste. Furthermore, it is important to consider that viscosity is a measurement of the inner friction of a fluid. Thus, if a solution flows easily it has a low viscosity and the interactions between the particles are very small. As the paste is considered chemically to be a colloid (a solid dispersed into a liquid), this liquid (vehicle) may facilitate or inhibit the ionic dispersion from the paste; the lower the viscosity, the higher will be the ionic dissociation.[14]

There are three main types of vehicles. They are water-soluble substances such as water, saline, anesthetic solutions, carboxymethylcellulose, methylcellulose and Ringers solution; Viscous vehicles such as glycerine, polyethyleneglycol (PEG) and propylene glycol; Oil-based vehicles such as olive oil, silicone oil, camphor oil, some fatty acids (including oleic, linoleic, and isostearic acids), eugenol and metacresylacetate.[15]

AIM and Objectives

Aim

The aim of the in vitro study is to determine the Sustained Release of Calcium Ions & pH maintenance from different vehicles containing calcium hydroxide using ultraviolet spectrophotometer and pH meter.

Objectives

The purpose of the in vitro study was to determine

1. The sustained release of calcium ions and pH maintenance from calcium hydroxide mixed with anesthetic solution.
2. The sustained release of calcium ions and pH maintenance from calcium hydroxide mixed with propylene glycol.
3. The sustained release of calcium ions and pH maintenance from calcium hydroxide mixed with olive oil.
4. To compare the sustained release of calcium ions and pH maintenance among the three groups used.

Material and Methods

The present in vitro study was carried out in the Department of Pedodontics and Preventive Dentistry, Rajah Muthiah Dental College & Hospital, Annamalai University in association with the Department of Physics, Annamalai University to determine the Sustained Release of Calcium Ions & pH maintenance from different vehicles containing calcium hydroxide using ultraviolet spectrophotometer and pH meter.

Materials

1. 30 extracted single rooted human teeth
2. Calcium hydroxide (SAFE PLUS)
3. Propylene glycol
4. Local anesthetic solution (Lidocaine Hydrochloride and Adrenaline Bitartrate) (NEON)
5. Olive oil (Baasaario olive oil)
6. 0.5 % sodium azide solution
7. Normal saline
8. Diamond disc
9. K file(MANI)- size 10 to size 45
10. Barbed broach (Dentsply)
11. G.G drills- 2 to 5 (Dentsply)
12. 2.5% sodium hypochlorite (NaOCl) (Prime Dental Products)
13. 17% Ethylene Diamine Tetracetic Acid(EDTA)(Anabond Private Products)
14. Distilled water
15. Air tight bottles
16. Glass vials (Borosil)
17. Endodontic finger pluggers (Dentsply)
18. Glass Ionomer – Fuji II (GC Japan)
19. Petroleum jelly (Bioline)
20. Molding wax (Hindustan products)

Methodology

Thirty extracted single rooted human teeth extracted for orthodontic and periodontal reasons were stored in 0.05% sodium azide solution. The crown of all the teeth were removed at the cementoenamel junction using a diamond disc under water /air spray and the length of each tooth was standardized to 15 mm. The root canals were enlarged initially up to size 20 using K files, the pulp tissue was removed using barbed broach. Later the working length of the root canal was determined by inserting a number 10 size K type file. Then the root canal of each tooth was instrumented with a circumferential filing technique up to size 45 apically. Coronally the canal was enlarged using Gates Glidden drills from number 2 to 5. After each instrumentation the canal was passively irrigated with 2ml of 2.5% sodium hypochlorite using stainless steel 27 gauge beveled needle. The final irrigation was performed with 2ml of 17% EDTA for 1 minute and finally the root canal was flushed with 5ml of distilled water to remove any precipitate of EDTA. Each tooth was stored in 5ml of saline in an air tight bottle.The specimens were then divided into 3 groups containing 10 specimens in each group.

Group I: calcium hydroxide with local anesthetic solution

One gram of calcium hydroxide powder is mixed with 2ml of the local anesthetic solution to get a paste.

Group II: calcium hydroxide with propylene glycol

One gram of calcium hydroxide powder is mixed with 2ml of propylene glycol to get a paste.

Group III: calcium hydroxide with olive oil.

One gram of calcium hydroxide powder is mixed with 2ml of olive oil to get a paste.

In all the three groups the formulations were introduced to the root canal using K files up to 1mm short of the working length. The file was then rotated counter clockwise and withdrawn along the canal walls. The formulations were further condensed with an endodontic plugger. While filling the root canals, each root was held in moist gauze to prevent the smearing of the formulations onto the root surface and also to maintain the tooth in a moist environment.The canal orifice of the root of all teeth was sealed with Glass Ionomer cement.Petroleum jelly was then applied on GIC to prevent it from the moisture contamination.The teeth were then suspended in a glass vials containing 10 ml of distilled water with the help of molding wax so that only the apical third of the roots were immersed into distilled water. After this, the pH and the calcium ions concentrations were measured. Solutions of

3ml were then withdrawn periodically at predetermined time intervals up to 24 hrs. (30 mins,1 hour, 2 hours, 4 hours,6hours,8hours,12 hours and 24 hours) and at 7, 15 and 30 days each time replacing with fresh distilled water. The vials were tightly closed with the help of molding wax to prevent the exposure of the distilled water to the atmosphere. The solutions were then analyzed using an ultraviolet spectrophotometer at 220 nm for the determination of calcium ion concentration.

Ph Measurement: The change in pH of all the different formulations is determined by dipping the electrode into the distilled water using pH meter. The comparison of mean calcium ion release and pH with different formulations are determined using analysis of variance (ANOVA) and Bonferroni "t" test. SPSS 10.0 version was used for analysis.

Results

The results were statistically analyzed using SPSS software 10.0 versions. ANOVA test and Bonferroni "t" test was applied to compare the mean calcium ion release and pH maintenance from calcium hydroxide with three different vehicles.

ANOVA test revealed that there was statistically significant difference between the three groups.Further Bonferroni "t" test was performed to find the statistical difference between the three groups.From the results of this in vitro study, it was concluded that.

1. Olive oil when used as a vehicle exhibited a sustained release of calcium ions from calcium hydroxide for prolonged duration when compared with propylene glycol and anesthetic solution.
2. All the vehicles used with calcium hydroxide maintained the alkaline pH at the end of one month, wherein propylene glycol showed the highest alkaline Ph.

Conclusion

Calcium hydroxide is the commonly preferred intracanal dressing in endodontics, its therapeutic effect mainly depends on its dissociation into calcium and hydroxyl ions, which in turn depends on the vehicles used. Within the limitations of the present study, further in vivo studies are required to confirm the effectiveness of calcium hydroxide mixed with different vehicles and to assess its clinical efficiency in root canal therapy.

Discussion

Root canal therapy has been practiced ever since 1928 and the success rate has tremendously increased over the years owing to various advancements in the field. The rationale for endodontic treatment is to eradicate the infection, to prevent microorganisms from infecting or re-infecting the root and periradicular tissues. Thus, a thorough understanding of the endodontic microbiota associated with different forms of disease is the basis for the success of endodontic treatment.[16] Bacteria are the primary etiological agents in pulpal and periapical inflammation; successful endodontic therapy depends on their reduction or elimination. When biomechanical instrumentation is combined with placement of an antimicrobial dressing for an appropriate length of time before root canal obturation, bacteria can be more effectively eliminated.[17]

All bacteria that are present in the oral cavity may invade the root canal during or after pulp pathosis, and thereby participate in endodontic infection. However, because of bacterial interactions and varying oxygen pressures inside the root canal, bacteria present in endodontic infections include a restricted group of species. The predominated organisms are obligate anaerobes, mainly Gram-negative bacilli, such as black-pigmentedrods and fusobacteria. Facultative anaerobes also are commonly isolated from infected root canals.[18]

Thorough disinfection of the root canal system is essential for the success of root canal therapy. This requires the use

of an intra-canal medicament. E. faecalis is the most frequently found species in persistent/secondary intracanal infection associated endodontic treatment failure.[19] Because of the complexity of root canal system some of the bacteria take refuge in ramifications, isthmuses, apical deltas and dentinal tubules even after chemomechanical preparation that needs to be eliminated byusing intracanal medicaments. The remaining anaerobic bacteria in the root canal system often result in failure of root canal treatment.[20] Chemomechanical preparation is one of the most important phases of endodontic treatment. However, it has been reported that bacteria may survive inside the root canal even after careful chemomechanical preparation. These remaining bacteria grow and multiply inside the root canal if no antibacterial dressing is used between the endodontic appointments. Thus, intracanal medication may be a valuable adjunct to chemomechanical preparation in the disinfection of the root canal system, reducing the endodontic microbiota and therefore favoring periapical tissue repair.[21]

Endodontic pain that may last from several hours to several days is linked to inflammatory reactions. This pain is dependent on the damage sustained by tissues and the nature of the damaging agent. These agents may be of a bacterial, chemical or mechanical nature. Endodontic pain may occur before, during, or after endodontic treatment.[22]

Information on the causes and the mechanisms behind inter-appointment pain in endodontics is important for the clinician to correctly prevent or manage this undesirable condition. The causative factors of inter-appointment pain cover mechanical, chemical, and/or microbial injury to the periradicular tissues, which are induced or aggravated during root canal treatment. When an inter-appointment emergency occurs, appropriate diagnosis and active treatment are required for the clinician to succeed in solving the problem. Certain factors have been recommended to significantly influence the development of inter-appointment pain including age, gender, tooth type, pulpal status, presence of preoperative pain, allergies and presence of sinus tract.[22]

A well-known post-operative complication of endodontic treatment is the acute exacerbation of symptoms or “flare-up”, after the debridement of the root canals and provisional restoration. Flare-up is the term commonly used to describe the characteristic symptoms of pain and swelling that may arise following endodontic treatment. Flare-ups have a multi-factorial etiology; including mechanical, chemical and/or microbial injury to the pulp or periradicular tissues. Microbial injury to the periradicular tissue is probably the commonest cause of flare-ups. Prevotella species and Porphyromonas species were frequently isolated from flare-up cases. Microbial insult, coupled with iatrogenic factors such as apical extrusion of contaminated debris, instruments, irrigants, and medicaments and filling materials, is one of the principal causes of postoperative pain.[23]

Intracanal medications are used as adjuncts to control flare-ups for several reasons:

a. Disinfection of the root canal by the action of an antibacterial agent (eg: antibiotics, phenol, surface acting agents); b. Reduction and control of periapical inflammatory reactions; c. Induction of the process of healing; d. Reduction of postoperative pain and discomfort.[24]

The use of an intracanal medication with antimicrobial activity between therapy sessions has been recommended to eliminate possible persistent microorganisms, particularly in cases of pulp necrosis with periradicular bone loss. In the treatment of apical periodontitis, intracanal medication has been recommended to eradicate the microbes that survive instrumentation and irrigation. Calcium hydroxide has been used in dentistry for almost a

century. It was originally introduced to the field of endodontics by Hermann in 1920 as a pulp-capping agent, but its uses today are widespread in endodontic therapy. Pure calcium hydroxide paste has a high pH (approximately 12.5-12.8). It is a basic compound; as such it is mildly irritating to vital pulp tissue. It has bacteriostatic properties which mean that it keeps bacteria from actively spreading.

Calcium hydroxide has a pronounced antimicrobial activity against most of the bacterial species found in root canal infections and is now used as an intracanal medication in endodontic therapy. The antimicrobial effectsof calcium hydroxide relate directly to its high pH (12.5). But to be effective against bacteria inside dentinal tubules, hydroxyl ions from calcium hydroxide must diffuse into dentin and reach sufficient pH levels to be lethal to the bacteria. Dentin hydroxyapatite has a strong buffering capacity that must be overcome by hydroxyl ions diffusing through the dentinal tubules, thus pH values reached may be insufficient to kill some bacterial species, especially E. faecalis that can survive at pH 11.5. This fact may contribute to the occurrence of reinfection or inflammatory root resorption.Although calcium hydroxide does not bond to dentin, it does have antibacterial property. Its mechanism of actions is achieved through the ionic dissociation of Ca^{2+} and OH^- ions and their effect on vital tissues, the induction of hard-tissue deposition and the antibacterial properties. The lethal effects of calcium hydroxide on bacterial cells are probably due to protein denaturation and damage to DNA and cytoplasmic membranes. It has a wide range of antimicrobial activity against common endodontic pathogens. It continues to have a high pH after setting because material dissolves readily in aqueous solution,liberatinghydroxyl ions. This high pH provides a stimulus for tooth to repair itself in absence of bacterial infection.

The advantages of calcium hydroxide are a) Initially bactericidal then bacteriostatic, b) promotes healing and repair, c) high pH stimulates fibroblasts, d) neutralizes low pH of acids, e) stops internal resorption, f) inexpensive and easy to use.

The high pH of calcium hydroxide formulations alters the biologic properties of bacterial lipopolysaccharides in the cell walls of gram-negative species and inactivates membrane transport mechanisms, resulting in bacterial cell toxicity. However, E. faecalis has been reported to be resistant to this effect as a result of its ability to penetrate the dentinal tubules and adapt to changing environment.Calcium hydroxide has been used in a plethora of situations for variety of purposes. Its extended use in endodontics has helped to treat perforations, resorption, weeping canals, conservative management of apical lesions, incompletely formed roots, root fractures etc. Its antibacterial action, tissue dissolving property, repairing ability and capacity to induce hard tissue formation makes it widely used as inter appointment dressing. Dissociation of calcium into Ca^{2+} and OH^- leads to high pH and activation of alkaline phosphatase, which are responsible for its actions. Hence, calcium hydroxide was selected for the present study.

In the present study 30 single rooted human teeth extracted for orthodontic purpose or periodontal purpose were selected to determine the sustained release of calcium ions and pH maintenance from different vehicles containing calcium hydroxide using ultraviolet spectrophotometer and pH meter.The three types of vehicles which were mixed with calcium hydroxide are; An aqueous vehicle (anesthetic solution), viscous vehicle (propylene glycol) and an oily vehicle (olive oil).

The results were statistically analyzed using SPSS software 10.0 version. ANOVA test and Bonferroni “t” test was applied to compare the mean calcium ion release

and pH maintenance from calcium hydroxide with three different vehicles.ANOVA test revealed that there was statistically significant difference between three groups. Further Bonferroni "t" test was performed to find the statistical difference between the three groups.

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TABLE -1: Tabulation Of Mean Calcium Ion Release From Calcium Hydroxide Paste Mixed With Three Different Vehicles During A Period Of 30 Days.

Time Interval	Anesthetic Solution (Group I)	Propylene Glycol (Group II)	Olive Oil (Group III)
30 min	0.192	0.181	0.182
1 hour	0.188	0.169	0.186
2 hour	0.206	0.201	0.188
4 hour	0.217	0.169	0.191
6 hour	0.183	0.181	0.212
8 hour	0.192	0.169	0.181
12 hour	0.159	0.216	0.178
24 hour	0.155	0.19	0.256
7th day	0.161	0.21	0.239
15th day	0.152	0.207	0.281
30th day	0.189	0.201	0.293

Table 1 shows the mean calcium ion release in which

a) Group I (calcium hydroxide with anesthetic solution) showed a mean value of 0.189 at the end of 30th day.

b) Group II (calcium hydroxide with propylene glycol) showed a mean value of 0.201 at the end of 30th day.

c) Group III (calcium hydroxide with olive oil) showed a mean value of 0.293 at the end of 30th day.

TABLE 2: Mean Calcium Ion Release from Calcium Hydroxide Paste Mixed With Three Different Vehicles

GROUP	N	Mean	Std. Deviation	F - Value	P- Value
Anesthetic Solution (Group I)	10	0.181	0.021	4.344	0.02 (Significant)
Propylene glycol (Group II)	10	0.190	0.017		
Olive oil (Group III)	10	0.217	0.042		

Table 2 Illustrates ANOVA test results for calcium ion release in which

a) Group I (calcium hydroxide with anesthetic solution) showed a mean value of 0.181 and a standard deviation of 0.021.
b) Group II (calcium hydroxide with propylene glycol) showed a mean value of 0.190 and a standard deviation of 0.017.
c) Group III (calcium hydroxide with olive oil) showed a mean value of 0.217 and a standard deviation of 0.042.
d) The results showed an f-value of 4.344 and a p-value of 0.02 (significant). The results revealed that Group III (calcium hydroxide with olive oil) showed statistical significant difference when compared to the other two Groups with a $p<0.02$.

Table 3: Comparison Of Calcium Ion Release From Calcium Hydroxide Paste Mixed With Three Different Vehicles.

Group	N	Mean	Std. Deviation	t- test	p-value
Anesthetic solution (Group I)	10	0.181	0.021	0.85	0.41 (Not significant)
Propylene glycol (Group II)	10	0.190	0.017		
Anesthetic solution (Group I)	10	0.181	0.021	2.12	0.05 (Significant)
Olive oil (Group III)	10	0.217	0.042		
Propylene glycol (Group II)	10	0.190	0.017	2.29	0.04 (Significant)
Olive oil (Group III)	10	0.217	0.042		

Table 3 Illustrates the "t" test results for calcium ion release in which

a) There was statistical significant difference between Group III (calcium hydroxide with olive oil) and Group II (calcium hydroxide with propylene glycol) with a $p<0.04$ and a t-value of 2.29.
b) Group III (calcium hydroxide with olive oil) showed statistical significant difference when compared to Group I (calcium hydroxide with anesthetic solution) with a $p<0.05$ and a t-value of 2.12.
c) There was no statistical significant difference between group I (calcium hydroxide with anesthetic solution) and group II (calcium hydroxide with propylene glycol) with a $p>0.41$ and a t-value of 0.85.

TABLE 4: Tabulation of Mean Ph Maintenance over a Period of 30 Days.

Time Interval	pH Group I	pH Group II	pH Group III
30 min	7.65	7.95	7.75
1 hour	8.01	8.2	8.13
2 hour	8.1	8.23	8.13
4 hour	8.2	8.27	8.02
6 hour	7.99	8.11	8.12
8 hour	8.01	8.13	8.13
12 hour	8.1	8.21	8.15
24 hour	8.2	8.25	8.25
7th day	8.06	8.25	8.15
15th day	8.11	8.4	8.32
30th day	8.15	8.37	8.26

Table 4 reveals that,

a) Group I (calcium hydroxide with anesthetic solution) showed a mean value of 8.15 at the end of 30th day.
b) Group II (calcium hydroxide with propylene glycol) showed a mean value of 8.37 at the end of 30th day.
c) Group III (calcium hydroxide with olive oil) showed a mean value of 8.26 at the end of 30th day.

TABLE 5: Mean Ph Maintenance from Calcium Hydroxide Paste Mixed With Three Different Vehicles.

GROUP	N	Mean	Std. Deviation	F - Value	P-Value
Anesthetic Solution (Group I)	10	8.052	0.151	3.60	0.04 (Significant)
Propylene glycol (Group II)	10	8.215	0.123		
Olive oil (Group III)	10	8.128	0.149		

Table 5 shows the ANOVA test results performed for the pH maintenance in which

a) Group I (calcium hydroxide with anesthetic solution) showed a mean value of 8.052 and a standard deviation of 0.151.

b) Group II (calcium hydroxide with propylene glycol) showed a mean value of 8.215 and a standard deviation of 0.123.

c) Group III (calcium hydroxide with olive oil) showed a mean value of 8.128 and a standard deviation of 0.149.

d) The analysis revealed that Group II (calcium hydroxide with propylene glycol) showed statistical significant difference when compared with the other two Groups with a $p<0.04$.

TABLE 6: Comparison of Ph Maintenance from Calcium Hydroxide Paste Mixed With Three Different Vehicles.

Groups	N	Mean	Std. Deviation	t-test	p-value
Anesthetic solution (Group I)	10	8.0527	0.151	6.51	0.001 (Significant)
Propylene glycol (Group II)	10	8.2155	0.123		
Anesthetic solution (Group I)	10	8.0527	0.151	2.55	0.02 (Significant)
Olive oil (Group III)	10	8.1282	0.149		
Propylene glycol (Group II)	10	8.2155	0.123	3.56	0.005 (Significant)
Olive oil (Group III)	10	8.1282	0.149		

Table 6 shows the "t" test results performed for the pH maintenance in which

a) Group I (calcium hydroxide with anesthetic solution) showed statistical significant difference when compared with Group II (calcium hydroxide with propylene glycol) with a $p<0.001$ and a t- value of 6.51.

b) There was statistical significant difference between Group III (calcium hydroxide with olive oil) and Group II (calcium hydroxide with propylene glycol) with a $p<0.005$ and a t-value of 3.56.

c) Group III (calcium hydroxide with olive oil) showed statistical significant difference when compared to Group I (calcium hydroxide with anesthetic solution) with a $p<0.02$ and a t-value of 2.55.

Figure Legends

Figure 1: Materials

Figure 2: Tooth Samples

Figure 3: Decoronated tooth samples

Figure 4: Placement of the intracanal medicament

Figure 5: Glass vials

Figure 6: Ph Measurement using pH meter

Figure 7: UV Spectrophotometer for measuring calcium ion release

Fig no: 1

Fig no: 2

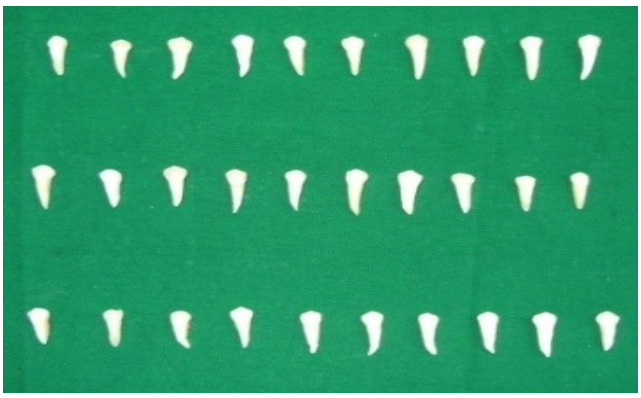

Fig no : 3

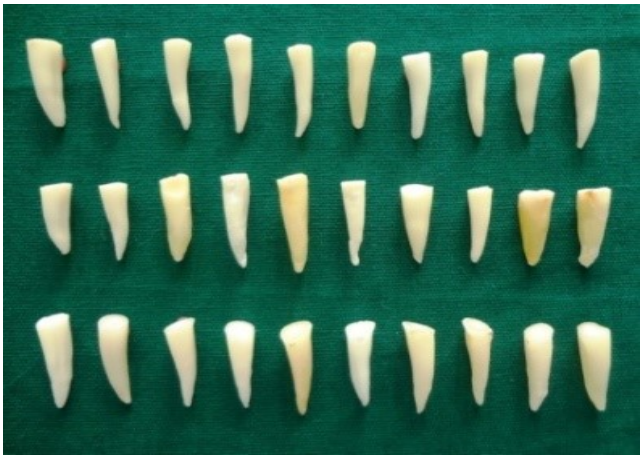

Fig no: 4

Fig no: 5

Fig no: 6

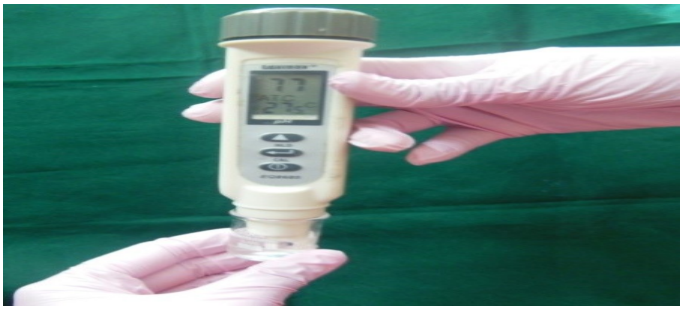

Fig no: 7