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Evaluation of Fracture Resistance of Human Root Dentin when Exposed to Various Intracanal Medicaments -An In-Vitro Study

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Abstract **Original Research Article**

***Objective*:** The aim of the present study is to compare the in vitro changes in the fracture resistance of human root dentin when exposed to calcium hydroxide+2 % chlorhexidine solution, ledermix, bioactive glass and MTA. ***Materials & Methods*:** 70 freshly extracted single rooted teeth were selected and were divided into five groups of 14 teeth each. Group 1-Saline group (control group), Group 2-Calcium Hydroxide and 2 % chlorhexidine solution combination, Group 3-Ledermix, Group 4-Bioactive Glass, Group 5-MTA. Coronal access and endodontic instrumentation was done using specified instruments and techniques. The prepared canal was then filled with saline solution, calcium hydroxide+2 % chlorhexidine solution, ledermix, bioactive glass and MTA and then teeth were sealed with bonded composite resin and teeth kept immersed in saline. After 30 days and 180 days the roots of 7 teeth from each group was sectioned horizontally into 1 mm thick disks depending upon length of root into 4-5 sections and each disk was placed under a universal testing machine and the peak load fracture was recorded and data were analysed accordingly. ***Results*:** 1) Results showed that the mean peak load at fracture of Group I (saline group) was higher in both 30 days and 180 days specimen. 2) Group 2 (Calcium Hydroxide and 2 % chlorhexidine solution) showed a decrease in the fracture resistance as compared to all other groups in 30 and 180 days. 3) Mean strength after 30 days for group 1 was 20.50, group 2 was 12.40, Group 3 was 17.20, Group 4 was 13.00, Group 5 was 14.80. 4) Mean strength after 180 days for group 1 was 19.10, group 2 was 11.30, Group 3 was 14.50, Group 4 was 13.40, Group 5 was 15.60. 5) ANOVA tests shows that there is significant difference as $p=0.000<0.01$. ***Interpretation and Conclusion*:** Based on the results of this study it can be concluded that both MTA and BAG can be efficiently used as an alternative to Calcium Hydroxide and 2 % chlorhexidine solution combination.

Keywords: Calcium hydroxide, chlorhexidine, mineral trioxide aggregate, bioactive glass, ledermix, fracture resistance.

INTRODUCTION

Ever since 1890, when W.D. Miller first observed the presence of microorganisms in pulpal and periapical diseases, microorganisms and their by-products are considered as the primary etiological agents of necrotic pulps and apical periodontitis. The main goal of endodontic therapy is to eliminate microorganisms from the root canal system and the prevention of subsequent reinfection [1]. Although the majority of bacteria are eliminated by biomechanical preparation of root canal space, a few microorganisms might still survive and thus the use of intracanal medication and the use of filling materials with antimicrobial and sealing properties are of essential importance, to avoid the growth of microorganisms. Modern dentistry incorporates endodontics as an integral part of restorative and prosthetic treatment [2].

Any tooth with pulpal involvement, provided that it has adequate periodontal support can be a candidate for root canal treatment [3]. Effective cleaning and shaping is the foundation of successful root canal treatment. However because of the complexity of the root canal systems, complete cleaning and shaping with presently available irrigants and instruments is difficult. Therefore intracanal medication has been advocated to further reduce the number of microorganisms between appointments. A wide range of chemicals have been used to disinfect the root canal

system including formocresol, cresatin, phenolic compounds, aldehydes, antibiotics, steroids and Ca(OH)2 [4].

Exposure of root dentin to these intra-canal medicaments may affect its physical properties. Despite these clinical successes, reports have surfaced correlating intracanal placement of calcium hydroxide with an increased incidence of tooth fracture [5, 6]. A number of investigators have attempted to demonstrate this trend [7-10]. Alternatives to $Ca(OH)_2$ have been proposed [11].

The aim of this study is to assess, evaluate and compare the fracture resistance of human root dentin when exposed to various intra-canal medicaments.

METHODOLOGY

The study was conducted in the Department of Conservative Dentistry and Endodontics, of Yenepoya Dental College, Mangalore, Department of Oral Pathology of Savitha Dental College, Chennai and Analytical Research And Metallurgical Laboratories Private Limited, Bangalore.

The Materials & Methods used for this study are described under following subheadings:

1. Selection of specimens,
2. Armamentarium,
3. Materials used for the study,
4. Specimen preparation,
5. Sectioning of teeth,
6. Fracture strength test,
7. Statistical analysis.

SELECTION OF SPECIMENS

Extracted single canal mandibular pre molars from the Department of Oral and Maxillofacial Surgery, Yenepoya Dental College.

Inclusion Criteria

Single rooted, non-fractured, unrestored premolar.

Exclusion Criteria

Multirooted, fractured, cracked, restored, calcified, resorbed or excessively curved rooted premolars.

MATERIAL AND ARMAMENTARIUM

- Bioactive glass,
- Ledermix,
- Calcium Hydroxide,
- 2 % Chlorhexidine solution,
- MTA,
- Normal Saline,
- Stainless steel K-files,
- Endo access bur,
- Sodium Hypochlorite solution,
- Self-Etching Dental Adhesive,
- Hard tissue microtome (LEICA SP 1600),
- Universal Testing Machine (Instron 3366).

SPECIMEN PREPARATION

70 freshly extracted single rooted teeth will be selected. Soft tissue & calculus were mechanically removed from the root surface of 70 selected specimens and will be divided into five groups of 14 teeth each.
Group 1-Saline group (control group),
Group 2-Calcium Hydroxide and 2 % chlorhexidine solution combination,
Group 3-Ledermix,
Group 4-Bioactive Glass,
Group 5-MTA.

Each tooth was accessed coronally with endo access bur and the canals were instrumented to a size of 20 stainless steel K-file, so that the file extended beyond the apical foramen by 1mm, followed by copious irrigation with NaOCl followed by sterile saline using 25 gauge needle, subsequently the canals were dried using paper points.

Group I

The root canals of the teeth in this group were filled with normal saline using syringe of 25 gauge needle. The coronal portion was sealed by placing a small cotton pellet into the pulp chamber and then single step self-etching dental adhesive (XENO- III) was used. According to manufactures recommendation, liquid from both Bottle A and Bottle B in equal amounts (approximately a drop each) was dispensed in the CliXdish Light-Protective Dispensing Dish and mixed for approximately 5 seconds. Generous amount of the mix was applied onto the cavity surfaces and left for 20 seconds and then cured for 10 seconds. Apical seal was done by application of self-etch bonding agent followed by composite restoration. The teeth were soaked in saline-soaked gauge throughout the preparation procedures and then stored in 0.9% saline at room temperature in a beaker. Group I formed the control group of the study.

Group II

The root canals of teeth in Group II were filled with a mixture of $Ca(OH)_2$ and 2 % chlorhexidine solution. $Ca(OH)_2$ and 2 % chlorhexidine solution were mixed to form a paste. Excess material was intentionally extruded past the apex. As with Group I, the teeth in Group II were sealed apically and coronally by placing a small cotton pellet into the pulp chamber and then applying self-etching dental adhesive (XENO III) followed by composite restoration. The teeth were then stored in 0.9% saline at room temperature in a beaker.

Group III

The canals of the teeth in this group were densely filled with Ledermix. The teeth were sealed as

that of the control group and stored in 0.9% saline at room temperature in a beaker.

Group IV

The canals of the teeth in this group were densely filled with Bioactive glass. Bioactive glass powder was mixed distilled water with according to the manufacturer's instructions. The teeth were sealed as that of the control group and stored in 0.9% saline at room temperature in a beaker.

Group IV

As per the manufactures instruction the Pro Root MTA powder and liquid were mixed on the mixing pad and the canals of the teeth in this group were densely filled taking the mixed MTA on the tip of finger plugger (size 20). The teeth in this group were sealed apically and coronally like the previous groups and stored in 0.9% saline at room temperature in a beaker.

SECTIONING OF TEETH AND FRACTURE RESISTANCE TEST

After 30 days seven teeth from each group were sectioned horizontally into 1 mm thick discs starting from apical 1/3rd into 3-4 sections using microtome and each horizontal section was placed under universal testing machine and a mounted punch with 1.2mm cross section was centered between the canal and the outside edge of the dentin disc and lowered onto the specimen at a cross head speed of 2.5mm/min until the specimen fractured. The test machine software automatically recorded the peak load at fracture and values noted. Similarly after 180 days, the remaining seven teeth from each group were taken from the saline storage containers and tested in the same manner as that of 30 day's group. The mean peak load at fracture for each group was calculated and the results from all groups were compared by one-way ANOVA and a Post-hoc student-Newman-Keuls test.

Figure 1: Study Samples

Figure 2: Different Groups

Figure 3: Materials & Armamentetarium Used

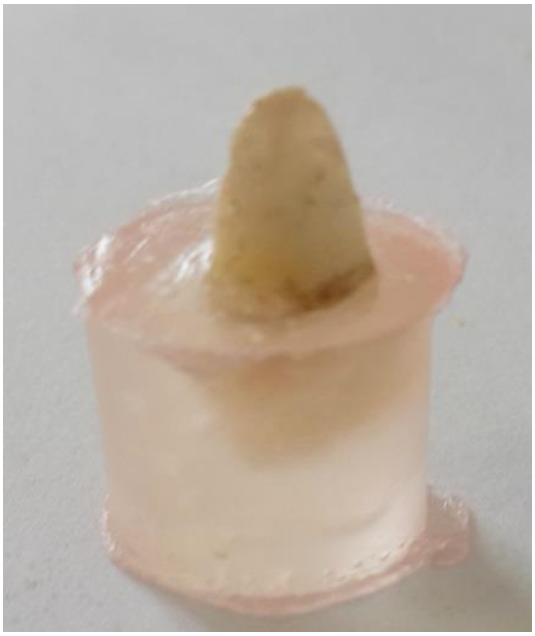


Figure 4: Hard Tissue Microtome

Figure 5:Tooth Mounted For Sectioning

Figure 6: Sectioning of Teeth

Figure 7: Sectioned Specimen

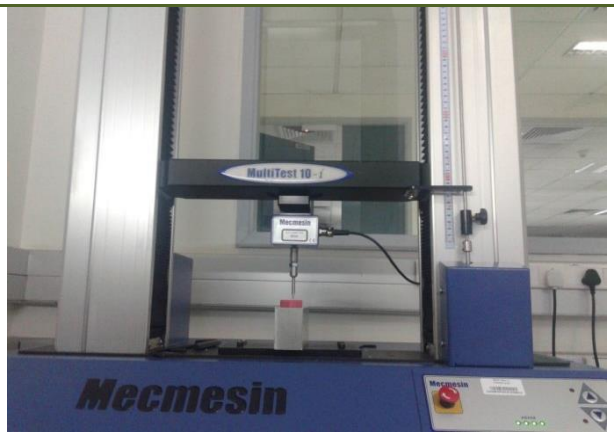


Figure 9: Fracture Resistance Test

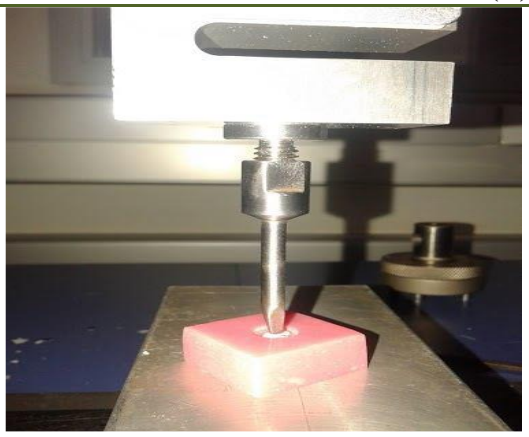


Figure 8: Universal Testing Machine

Figure 10: Specimen after the Fracture Resistance Test

Statistical Analysis

Results are presented as Mean + SD and Range values. One way ANOVA was used for multiple comparisons followed by Post-hoc Neuman-Keul's test for graphic comparisons. Student's t-test was used for comparing peak load at fracture between 30 and 180 days. For all the tests, a P-value of 0.05 or less was considered for statistical significance.

Table 1: Peak Load at Fracture of Specimen after 30 Days

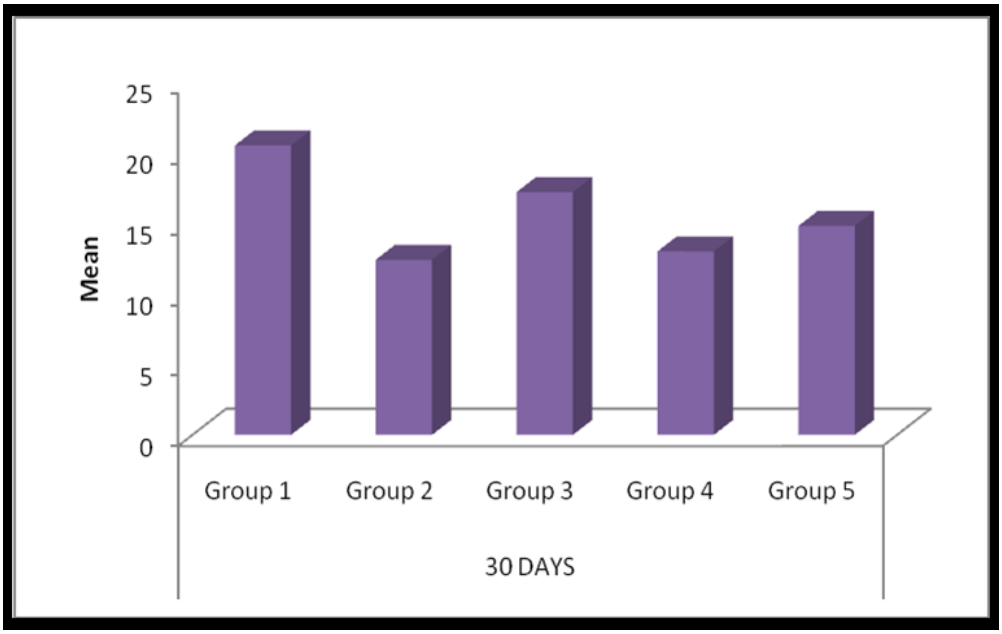
30 DAYS							
				95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Lower Bound	Upper Bound	ANOVA F	p
Group 1	21	20.50	3.91	18.72	22.28	11.428	.000
Group 2	21	12.40	3.75	10.69	14.11		HS
Group 3	21	17.20	4.92	14.96	19.44		
Group 4	21	13.00	4.71	10.86	15.14		
Group 5	21	14.80	5.08	12.49	17.11		

Table 2: Difference between Groups after 30 Days

POST HOC ANALYSIS

30 DAYS

		Mean Difference	Std. Error	p	
Group 1	Group 2	8.10	1.39	.000	HS
	Group 3	3.30	1.39	.196	
	Group 4	7.50	1.39	.000	HS
	Group 5	5.70	1.39	.001	HS
Group 2	Group 3	-4.80	1.39	.008	HS
	Group 4	-.60	1.39	1.000	
	Group 5	-2.40	1.39	.875	
Group 3	Group 4	4.20	1.39	.032	sig
	Group 5	2.40	1.39	.875	
Group 4	Group 5	-1.80	1.39	1.000	



Graph 1: Bar Graph Showing Peak Load at Fracture of Inter Group Specimen-30 Days

Table 3: Peak Load at Fracture of Specimen after 180 Days

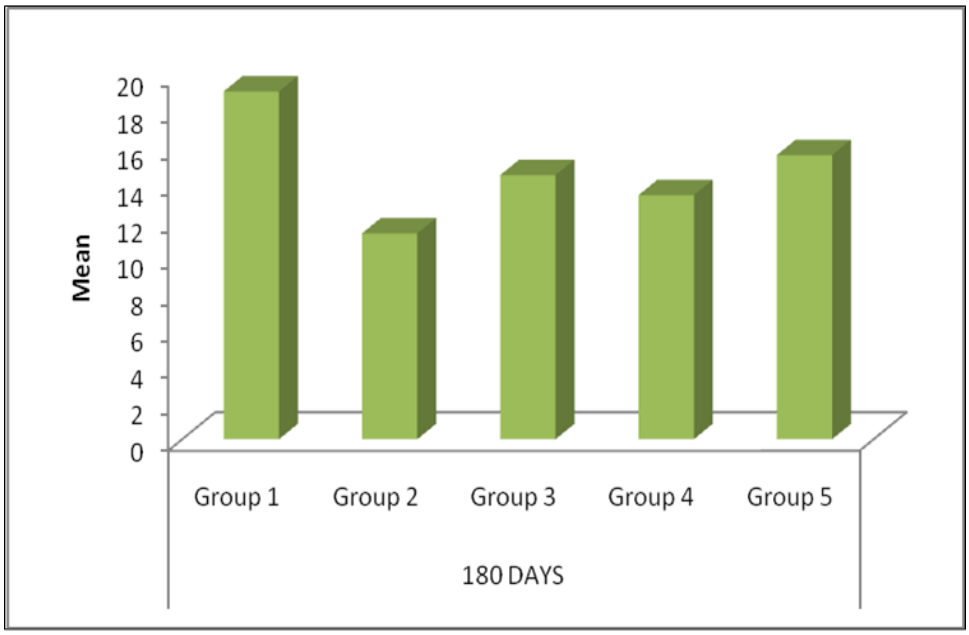
180 DAYS							
				95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Lower Bound	Upper Bound	ANOVA F	p
Group 1	21	19.10	3.80	17.37	20.82	10.819	.000
Group 2	21	11.30	3.81	9.57	13.03		HS
Group 3	21	14.50	4.17	12.60	16.40		
Group 4	21	13.40	3.07	12.00	14.80		
Group 5	21	15.60	5.02	13.31	17.89		

Table 4: Difference between Groups after 180 Days

POST HOC ANALYSIS

180 DAYS

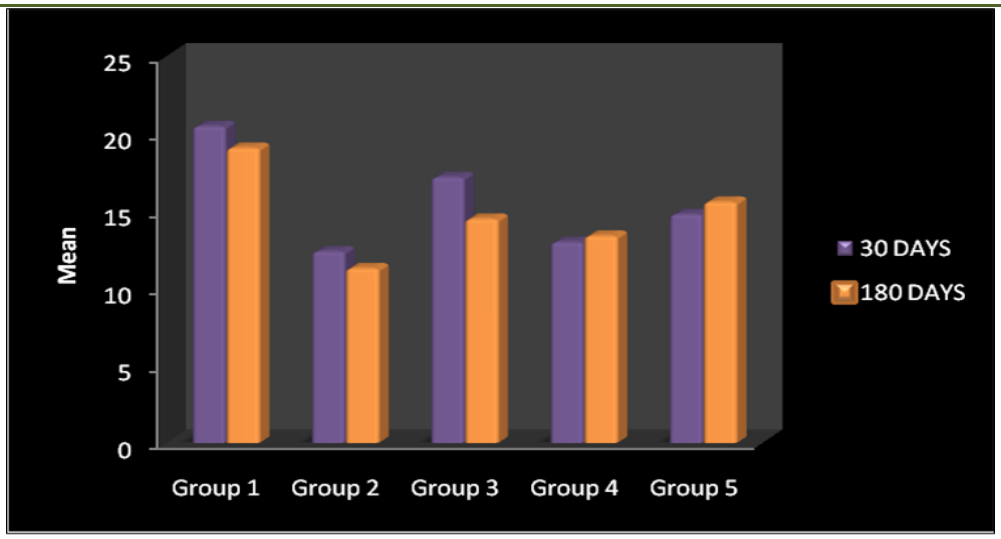
		Mean Difference	Std. Error	p	
Group 1	Group 2	7.80	1.24	.000	HS
	Group 3	4.60	1.24	.004	HS
	Group 4	5.70	1.24	.000	HS
	Group 5	3.50	1.24	.046	sig
Group 2	Group 3	-3.20	1.24	.115	
	Group 4	-2.10	1.24	.940	
	Group 5	-4.30	1.24	.008	HS
Group 3	Group 4	1.10	1.24	1.000	
	Group 5	-1.10	1.24	1.000	
Group 4	Group 5	-2.20	1.24	.796	



Graph 2: Bar Graph Showing Peak Load at Fracture of Inter Group Specimen-180 Days

Table 5: Peak Load at Fracture of Inter Group & Intra Group Specimen Comparison within the Group 30 to 180 Days

		N	Mean	Std. Deviation	Mean differenvce	change (%)	t value	p
Group 1	30 DAYS	21	20.50	3.91	1.4048	6.85	1.298	.209
	180 DAYS	21	19.10	3.80				NS
Group 2	30 DAYS	21	12.40	3.75	1.1000	8.87	.958	.349
	180 DAYS	21	11.30	3.81				NS
Group 3	30 DAYS	21	17.20	4.92	2.7000	15.70	2.172	.042
	180 DAYS	21	14.50	4.17				sig
Group 4	30 DAYS	21	13.00	4.71	-.4000	-3.08	.313	.758
	180 DAYS	21	13.40	3.07				NS
Group 5	30 DAYS	21	14.80	5.08	-.8000	-5.41	.669	.511
	180 DAYS	21	15.60	5.02				NS



Graph 3: Bar Graph Showing Peak Load at Fracture of Inter Group & Intra Group Specimen Comparison within the Group 30 to 180 Days

RESULT

Fracture Resistance

Mean strength after 30 days for group 1 was 20.50, group 2 was 12.40, Group 3 was 17.20, Group 4 was 13.00, Group 5 was 14.80.

Mean strength after 180 days for group 1 was 19.10, group 2 was 11.30, Group 3 was 14.50, Group 4 was 13.40, Group 5 was 15.60.

Results showed that the mean peak load of fracture of control group (group I) was higher in both 30 day and 180 day specimen.

ANOVA tests shows that there is significant difference as $p=0.000<0.01$.

DISCUSSION

The use of $Ca(OH)_2$, in dentistry is well established and wide-spread. It was introduced to endodontics by Hermann in 1920 and has been used extensively in multiple endodontic applications.

$Ca(OH)_2$ has been used in various formulations as -

1. Liner beneath restorations,
2. Pulp capping agent,
3. Intracanal medicament,
4. Apexification,
5. Antibacterial agent,
6. Used for control of inflammatory root resorption after luxation and avulsion injuries [6].

$Ca(OH)_2$ is believed to have many of the properties of an ideal root canal dressing, mainly due to its alkaline pH [41, 42]. It is bactericidal [43] and neutralizes the remaining tissue debris in the root canal system [44]. $Ca(OH)_2$ also promotes an alkalinizing osteogenic environment on the surrounding tissues through the continuous release of hydroxyl ions [45]. Furthermore, $Ca(OH)_2$ mediates the neutralization of lipopolysaccharides [46] and thus helps in cleansing the root canal.

Estrela *et al.*, [47] claimed that $Ca(OH)_2$ inhibits bacterial enzymes by means of hydroxyl ions of the bacteria's cytoplasmic membrane, generating the antibacterial effect. It activates tissue enzymes such as alkaline phosphatase, leading to the mineralizing effect.

For calcium hydroxide to act effectively as an intra- canal dressing, it should ideally occupy all the pulp space thereby diffusing into areas inaccessible to instruments. Its effectiveness is linked to the diffusion of hydroxyl ions through the dentinal tubules and accessory canals into areas where bacteria and their by-products may be harboured. In addition to acting as a physical barrier, the calcium hydroxide dressing may both prevent root canal re-infection and interrupt the nutrient supply to the remaining bacteria. Its alkalizing pH (around 12.5) promotes a destructive effect on cell membranes and protein structure [48].

However, $Ca(OH)_2$ cannot be considered as a universal intracanal medicament, since it is not equally effective against all bacteria found in the root canal [49] Indeed, several studies [50-52] have reported the failure of $Ca(OH)_2$ to eliminate Enterococci effectively as they tolerate high pH values, varying from 9 to 11.

Chlorhexidine has been widely used in periodontics [53]. It has antimicrobial activity against Gram-negative and Gram-positive microorganisms. The antimicrobial effect of chlorhexidine is related to the cationic molecule binding to negatively charged bacterial cell walls, thereby altering the cell's osmotic equilibrium.18 Its use in endodontics has been proposed as an irrig- ant [53-56] as well as an intracanal medicament [57-61] Ohara *et al.*, [62] evaluated the

antibacterial effects of six irrigants against anaerobic bacteria and reported that chlorhexidine was the most effective. Ferraz *et al.,* [56] also claimed the antimicrobial property of 2% chlorhexidine gluconate gel. When used as an intracanal medicament, chlorhexidine was more effective than $Ca(OH)_2$ against *Enterococcus faecalis* infection in dentinal tubules [63, 64]. So a combination of $Ca(OH)_2$ and 2% Chlorhexidine is widely used nowadays.

Despite its efficacy, this dressing has several disadvantages such as variability of treatment time, number of appointments and radiographs, difficulty in patient follow up, delayed treatment and possibility of increased tooth fracture after $Ca(OH)_2$ used for extended periods [65]. It is also postulated that due to its strong alkalinity $Ca(OH)_2$ may denature the carboxylate and phosphate groups leading to a collapse in the dentin structure and thus leading to decreased fracture resistance [66]. Alternatives to $Ca(OH)_2$ have been proposed, the most promising being a recently developed material, MTA [9].

Torabinejad and colleagues at Loma Linda University in the 1990's introduced a cement called mineral trioxide aggregate (MTA, Dentsply Tulsa Dental) which appears to have all the characteristics of an ideal cement, above all, it is hydrophilic in nature which makes it compatible with moisture and also challenges to seal communication between the root canal system and oral cavity and between root canal system and the periodontium.

Clinical uses are:

1. Pulp capping,
2. Pulpotomy,
3. One -step-apexification,
4. Root end filling,
5. Perforation repair.

MTA consists of 50-75% (wt) calcium oxide and 15-25% silicon dioxide. These two components together comprise 70-95% of the cement. When these raw materials are blended they produce tricalcium silicate, di-calcium silicate, tricalcium aluminates and tetracalcium aluminoferrite. The initial pH of MTA when hydrated is 10.2 and the set pH is 12.5, which is comparable that of $Ca(OH)_2$ [15].

Recent studies on the material constituents have clarified that MTA is a silicate cement rather than oxide mixture [67].

Two forms of MTA material were categorized: the traditional grey MTA (GMTA) and white MTA(WMTA) was introduced as ProRoot MTA (Dentsply Endodontics, Tulsa, OK, USA).

Scanning electron microscopy (SEM) and electron probe micro analysis found that the major difference between GMTA and WMTA is in the concentration of Al_203 MgO, FeO. The concentration of FeO in WMTA is 90.8% less than GMTA which is the likely cause for the color change [15]

Besides its non cytotoxity, it has good biological action and stimulates repair, because it allows cellular adhesion, growth and proliferation on its surface.

Biologic response of MTA is because of its pH and calcium ions. The mechanism of action of MTA is similar to $Ca(OH)_2$ because of its alkaline pH, but in addition it provides better sealing than $Ca(OH)_2$.

When MTA reacts with water it forms calcium oxide and calcium phosphate. Calcium oxide reacts with water and tissue fluids to form $Ca(OH)_2$. This further dissociates into calcium and hydroxyl ions. The hydroxyl ions produce low grade irritation with the pulp tissue and are also responsible for the antimicrobial property of the material. Calcium ion reacts with carbon dioxide present in the pulp tissue to form calcite crystals to form fibrodentin, which is responsible for cellular adherence and differentiation. The condensation of fibronectin around the formed crystals permits cellular adherence and differentiation, seen as periodontium.

MTA is a relatively new material that has become the material of choice because of its promising properties, it has been considered as potential alternative restorative material to the presently used materials in endodontics [67].

On the other hand are the emerging trends towards use of bioactive glass which is silicate based, calcium and phosphate containing, with potential applications in dentistry [68].

Hench was the first to develop bioactive glasses (1969) and these glasses were able to bond to tissues [69]. Safety of these bioactive glasses was a concern, so various studies were performed to ensure that bioactive glasses are safe for clinical applications. Wilson *et al.,* (1981) reviewed these studies and proposed that bioactive glasses are safe for clinical use [70].

Bioactive glasses have a wide range of applications. Bioglass most commonly used for bone grafts [71]. Bioactive glasses help in the repair of hard tissues [72] and various compositions are being used nowadays for preparation of scaffolds [73] and as coating material for implants [74].

LitKowski *et al.,* (1997) conducted an *in vitro* study and used Bioglass™ (45S5) on dentinal surfaces of teeth and demonstrated increased occlusion of dentinal tubules by 45S5 as compared to non-45S5

compounds thereby proposed that it should also decrease dentine hyper-sensitivity in vivo [75].

In addition to remineralization, bioactive glasses have antibacterial effects [76] as they can raise the pH of aqueous solution [77]. The bioactive glass was able to induce tissue mineralization in mucosal explants as well as in dentin. Previous reports have shown that the material does not have harmful effects on human tissues and that it can, in fact, enhance human bone formation [78, 79]. It has also been shown that the material has a significant anti-bacterial effect [80]. Based on these results, the material has potential to be developed to dental health care products. This can be in the form of a mineralizing agent in caries prophylactics or a desensitizing agent in the treatment of hyper-sensitive teeth caused by opened dentinal tubules. In root canal therapy, a potential application of the BAG as a root canal sealing material can also be considered. If a biological HCA seal in the canal and at the root apex can be achieved, the glass is proved to meet the requirements of such materials. Further studies of the BAG are needed in order to validate its above-mentioned potential uses [81].

Glucocorticoids are drugs, frequently employed to avoid or reduce inflammation occurring after injuries or traumatic dental procedures. In addition, they can inhibit the progression of an inflammation, which would ultimately lead to necrosis of the pulp tissue. The anti-inflammatory effect of glucocorticoids, employed in the treatment of vital pulps after direct pulp capping, was first described by Rapoport *et al.,* [82] Later, glucocorticoids alone or in mixtures with antibiotics were applied as direct pulp capping agents or as liners in deep cavities to reduce pulpal pain [83-85]. Ledermix paste, developed by Schroeder [86], is a mixture of a glucocorticoid (triamcinolone) and an antibiotic (demeclocycline). Nowadays, two different types of Ledermix preparations are commercially available, which differ mainly in their consistency, and only slightly in their chemical composition. These preparations are Ledermix paste (1% triamcinolone, 3% demeclocycline-calcium) and Ledermix cement (0.7% triamcinolone, 3% demeclocycline-calcium).Ledermix paste was used in this study.

According to various authors the anti-bacterial and anti-inflammatory effects of Ledermix justify its employment, when inflammatory pulp conditions and apical lesions have been diagnosed. Schroeder[86]described the local application of glucocorticoids as a very effective therapy for pain reduction, especially in inflammatory pulp processes. Several authors [87-90] have discussed the potential anti-bacterial and anti-inflammatory effects of steroids, antibiotics, a combination of both agents, and calcium hydroxide in different investigations, often with controversial results. Hume *et al.,* [87], using radio-labeled H-triamcinolone, observed that the constituents of Ledermix were released into dentinal areas close to the pulp. The authors claim that immunosuppression, a possible side effect of long term corticoid application, can favor the progression of pulp disease. In his review, Mohammadi [91] reported that the application of glucocorticoid steroids has been found to be effective in reducing pain following endodontic treatment. Sazak *et al.,* [88] examined the teeth of dogs histopathologically for signs of pulp inflammation and formation of tertiary dentine after pulp exposure and application of calcium hydroxide/Ledermix or calcium hydroxide alone. After an observational period of 90 days, no difference was found between the two groups regarding the formation of reparative dentine. Ehrmann *et al.,* [89] showed that the employment of Ledermix resulted in a reduction of endodontic post-treatment pain.

The recent studies of immunoflorescence imaging revealed that the mechanical properties of dentin are fundamentally determined by dentin matrix which is mostly composed of collagen type I [15].

Matrix metalloproteinase (MMP)-2,-14 and membrane type 1 (MT1) are found to play an important role in the degradation of collagen matrix of dentin. On the other hand the tissue inhibitor of metalloproteinase (TIMP) inhibit the active forms of MMPs, especially TIMP-2 inhibits MMP-2. It is speculated that both calcium hydroxide and MTA in the root canals of dentin may affect the activities of MMP and TIMP-2, thus influence the mechanical properties of dentin [15].

According to histological analysis, except for TIMP-2 MMP-2,-14 were clearly observed in the dentin matrix of calcium hydroxide treated group, resulting in the degradation of organic matrix, thus reducing the fracture strength [15].

Expression of collagen type I, MMP-2,-14, and TIMP-2 on the dentin were noticed in MTA treated teeth. TIMP-2 prevented the organic matrix from degradation caused by MMP-2,-14 [15].

Therefore, the reason for high fracture resistance of dentin at long term might lie in the inhibitor activities of TIMP-2. Reduced expression of MMP-2, -14 for the MTA treated teeth may also contribute to the high fracture strength at the end [92].

The result of this study also demonstrated that use of Ca(OH)2 in combination with chlorhexidine solution reduced fracture resistance in accordance with study by Rosenberg *et al.,* [66] and MTA increases fracture resistance of dentin in accordance with study by Kofman *et al.,* [92].

SUMMARY

This study was done to test the fracture resistance of dentin after exposure to various intracanl

medicament after 30 days and 180 days.70 freshly extracted teeth were divided into five groups.
Group 1-Saline group (control group),
Group 2-Calcium Hydroxide and 2 % chlorhexidine solution combination,
Group 3-Ledermix,
Group 4-Bioactive Glass,
Group 5-MTA.

Coronal access and endodontic instrumentation was done using specified instruments and techniques. The prepared canal was then filled with saline solution, calcium hydroxide + 2% chlorhexidine solution, ledermix, bioactive glass and MTA and then was sealed with bonded composite resin and teeth were immersed in saline. After 30 days and 180 days the roots of 7 teeth from each group were sectioned horizontally into 1 mm thick disks depending upon length of root into 4-5 sections and each disk was placed under a universal testing machine and the peak load fracture was recorded and data was analyzed accordingly.

Within limitations of this in vitro study it can be summarized that dentin showed significant loss in fracture resistance after exposure to combination Calcium Hydroxide and 2 % chlorhexidine and Ledermix over the period of 180 days. While MTA and BAG showed increase in fracture resistance after 180 days when compared with the results after 30 days though increase in fracture resistance was not much significant.

CONCLUSION

On the basis of the procedure performed and the results obtained using a combination of $Ca(OH)_2$ and Chlorhexidine, Ledermix, Bioactive glass and MTA under universal testing machine to check the fracture resistance suggested that there was a subtle decrease in the fracture strength of root dentin when exposed to combination of $Ca(OH)_2$ + Chlorhexidine and ledermix in comparison to the other materials used in the study.

Based on the results of this study it can be concluded that both MTA and BAG can be efficiently used as an alternative to combination of $Ca(OH)_2$ and Chlorhexidine although further studies have to be conducted as there is limited information in the dental literature concerning the long term effects of the newer materials such as MTA and BAG.

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