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RESEARCH PAPER

Evaluation of Coronal Micro-Leakage of Fiber Post with Different Luting Cements (In Vitro Study)

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A B S T R A C T:

Background and Objectives: *This research's objective was to analyze coronal micro-leakage of fiber post using the various types of luting cements.*

Methods: Thirty extracted mandibular single rooted premolars underwent instrumentation with rotary protaper® system and obturated with protaper® gutta-percha and AH-plus® root canal sealer. After being incubated for twenty-four hours, the post space preparation was done through the usage of the Unicore® post drill #2 forming 8mm deep post space and the identical size of Unicore® fiber post #2 was positioned. The samples that went through preparation were arbitrarily placed within three groups representing the three kinds of luting cement **(G1:** RelyX Unicem, **G2:** TotalCem, **G3:** GC Fuji I). *Two layers of nail polish were placed upon the root's surfaces. However, the coronal 2mm was not painted, and the samples were individually placed within* 10% black Indian ink dye for the time period of seventy-two hours. *The samples underwent rinsing and removal of nail polish, after that the clearing and decalcifying of the samples were performed.* One Way Analysis of Variance (ANOVA) used to test any statistically significant difference among the groups also Turkey's HSD (Honest Significant Difference) post hoc multiple comparison test used for comparison among the groups after using ANOVA test.

Results: The results of the present study showed that groups luted with G1 and G2 better coronal sealing than group which luted with G3, which presented that no statistically noteworthy variances were identified among G1 and G2, but substantial variances were present among (G3) further groups.

Conclusion: TotalCem ability for coronal sealing surpassed that of RelyX Unicem.

KEY WORDS: Micro-leakage, Fiber post, Self-Adhesive resin cement
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1. INTRODUCTION:

Application of fiber posts is frequently utilized to sustain core substances on teeth that have gone through endodontic treatment and undergone substantial damage to the coronal tooth structure.[1] The usage of fiber posts has various benefits that surpass the metal form. Favourable fracture patterns that are more likely to be restorable due to a lesser degree of rigidness, and its removal within the root canal is simpler for endodontic retreatment.[1,2] There is a greater strength between the resin core and fiber post in comparison to its relation to the metal post.[3] Moreover, fiber posts are formed from quartz and glass fibers, which have white shade as well as provide the anterior sections with enhanced aesthetics.[4] Resin cement can be divided into categories of self-adhesive, adhesive, and conventional.[5] Self-adhesive resin cement has been newly presented, and its application has convenience because of the lack of sensitivity to techniques; and conditioning process is not a necessity. Also, the adhesive resin cement must

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have an acidic self-etching primer as well as bonding to the dentin that does not necessitate rinsing. Lastly, conventional resin cements supply improved aesthetics as well as constructive compressive strength due to their components being identical with the restorative resin composites.[6] Moreover, there are various kinds of resin cement offered, which consist of light-cure, chemical-cure, and dual-cure. Dental curing light is applied for the polymerization of the light-cured form. Resin cement of the chemical-cured form sets off polymerization by a catalyst being combined with base substances. Most resin cements available consist of dual-cured type, which goes through polymerization by the catalyst substances as well as the base being combined or exposure to curing light occurs. Resin cement that is dual-cured provides a longer period to work with the material.[5] Conversely, the light-curing process is a necessity when working with dual-cured resin because it presents weaker hardness without it.[7] Micro-leakage can arise due to inefficient post adaptation that forms marginal gaps within incidents of deficient cementation. Leakage is the most commonly occurring event that leads to a lack of success for post cores and inducts the post and root division.[8] Marginal discolorations, fractures, and secondary caries are caused by the areas between the repairs and teeth being infiltrated by various ions forms, oral liquids, and bacterial impurities.[9]

Furthermore, the range of researches that examines the luting materials leakage influence upon later endodontic failure is limited. This research's purpose focuses on comparing the fiber post coronal micro-leakages by applying luting cement of three diverse kinds. Additionally, the null hypothesis to be tested is that there is no difference in coronal microleakage of fiber posts luted with different luting cements.

Materials and Methods

Sample selection and preparation:

Thirty mandibular premolars extracted for the purpose of orthodontics were chosen to be utilized in this study. The premolars with one straight root and root canal, no previous endodontic treatment, no fractures, no caries, and no external resorption were selected. A micro saw (Diamond wheel, Norderstedt, Germany) with a low speed handpiece was used to separate the clinical crowns and to obtain an average length of 12 mm of the root. Canal patency was tested by #10 stainless steel K-file of 1mm passing through the apical foramen. Subsequently, the teeth were kept in distilled water, which was replaced every two days according to the guidelines of (ISO/TS 11405).[10] Furthermore, a mold made of silicon rubber base was used to hold the roots, and they were placed into the middle of putty material within a plastic tube with the help of a dental surveyor and one mm of the root was above the putty material. The placement was put in such a way that the root axis was parallel to the tube's long axis. This method forms a small block to aid in the roots management throughout the process of obturation and instrumentation.

Mold preparation and instrumentation:

During the process of instrumentation, the molds were secured by bench vice for standardization. Moreover, the preparations for root canals were conducted based on the manufacturer instructions with a set of ProTaper Ni-Ti rotary mechanisms. The endodontic procedures were completed with the use of F3 ProTaper files.

According to Kosti *et al*., five 5ml of 5.2% NaOCl was used as an irregant at each change instrument,.[11] Then, paper points were used to dry the canals (F3 Dia-Pro®, Korea). Single cone method with the use of the F3 ProTaper gutta-percha (Dia-Pro, Korea) was utilized to obturate the prepared canals. The combined AH-Plus resin(Denstply, DeTrey, Germany) was put onto the top of the lentulo spiral #30 and inserted into the canal. Also, the apical region of the F3 master-cone was slightly covered with a sealer and inserted into the canal to the full working length. Caviton® (GC, Tokyo, Japan) was used to seal the open access temporarily. The specimens were placed into different plastic vials that contained distilled water. The vials were kept at a storage of 37°C, and the humidity was 100% in an incubator for one day to enable complete setting of the sealer as suggested by D'Arcangelo *et al*.[12]

Post space preparation and cementation:

AF350 (AMANN Girrbach, Germany), which is a parallel milling device, was utilized to prepare post space (Figure 1: A, B). The canals were enlarged and formed with a fiber post drill with a size of 2 (UniCore®, Ultradent) (Figure 2) with the milling device that has a straight handpiece with a low-speed

of 20,000 RPM. This was used to achieve a vertical formulation with a regular diameter and parallel to the root long axis. The extent of the post space was eight millimeters, and four millimeters of gutta-percha were left to guarantee a clinically approved apical seal as described by Zorba *et al*.[13]

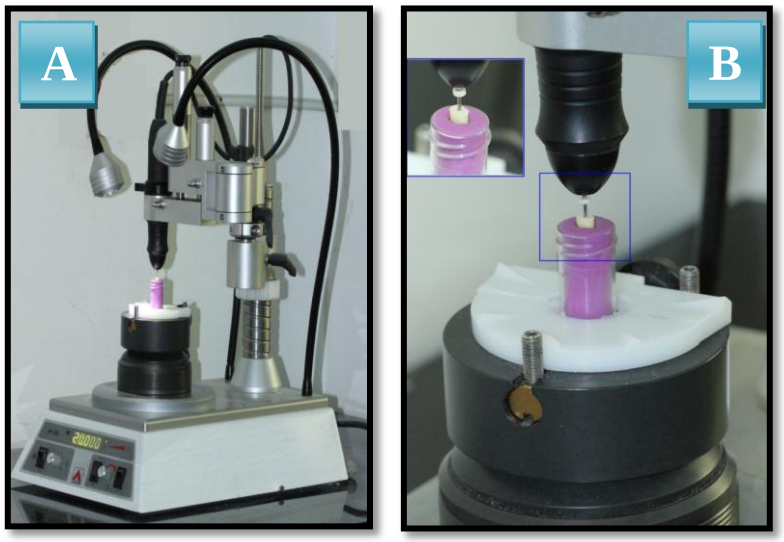

Figure 1: Post space preparation: (A) Parallel milling device AF350 (B) Shaping of a canal with post drill

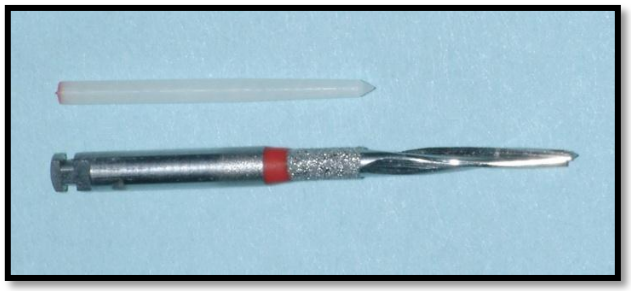

Figure 2: UniCore fiber post and drill size 2

The specimens were divided into three groups according to the type of luting cement used, which included Group 1: RelyX Unicem, Group 2: TotalCem, and Group 3: GC Fuji I.

Table (1) shows the list of luting cements and the constituents of each one. Prior to cementing, each fiber post was sanitized with the use of alcohol and dried with air free of water.

Table 1: Types and compositions of the luting cements

Materials		Composition	Curing mode
RelyX Unicem	**Base**	Methacrylate monomers containing phosphoric acid-groups Methacrylate monomers Silanated fillers Initiator components Stabilizers	Dual cure

	Catalyst	Methacrylate monomers Alkaline (basic) fillers Silanated fillers Initiator components Stabilizers Pigments	
TotalCem	**Base**	Urethandimethacrylate Oligomer Triethyleneglycoldimethacrylate Co-initiator Photo initiators Barium aluminoborosilicate glass	Dual cure
	Catalyst	Urethandimethacrylate Oligomer Triethylenglycoldimethacrylate 4-Methacryloxyethyltrimellitic acid Benzoyl peroxide Barium aluminoborosilicate glass	
GC Fuji I	**Base**	Alumino-fluoro-silicate glass Polyacrylic acid	Chemical cure
	Catalyst	Polyacrylic acid Distilled water	

Irrigation of the root canal was completed with 2.5% NaOCL and washed instantly with distilled water (2ml). The canal was then dried with paper point(proptaper #3). Prior to the cementing process, the posts were each marked at eight millimeters from the apical side. The cementation of the fiber posts into the root canals was completed according to the manufacturer's guidelines for the luting cement, which was similar for both the TotalCem automix (Itena, France) and RelyX Unicem automix (3M ESPE, Germany). After the endo tip and mixing tip were attached to the syringe, about 8 mm of mixing tip was inserted then the cement was injected with slow backward movement (Figure 3). For five seconds, continuous and slight pressure was applied to secure the fiber posts in place and to remove the access easily with a sharp probe as instructed by Baldea *et al.*[14]

Then, the fiber posts were cured with Light Emitting Diode (WOODPECKER, Guangxi, China) with an intensity of 500mW/mm^2 for 40 seconds from the occlusal. For [GC Fuji I (GC, Japan)], a mixture of one scoop of powder with two drops of liquid. Then, the cement was applied to the inside of the canal by lentulo spiral, and the fiber post was placed inside (Figure 4). For five seconds, finger pressure was applied to secure the fiber posts, and extra cement was cleaned off with cotton plat. The setting time was 4minutes and 30seconds (manufacturer instructions). The roots were removed from the silicone mold following post placement. Then, they were placed separately within glass vials that are sealed tightly to be incubated throughout a 24-hour period at a temperature of 37°C ± 1 (100% humidity).

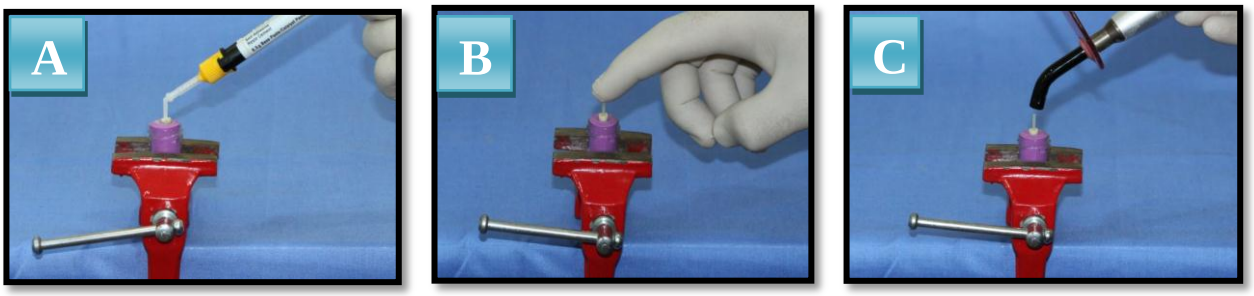

Figure 3: RelyX Unicem cementation (A) RelyX Unicem Automix Endo tip (B) Finger pressure was applied (C) Light cure from occlusal direction

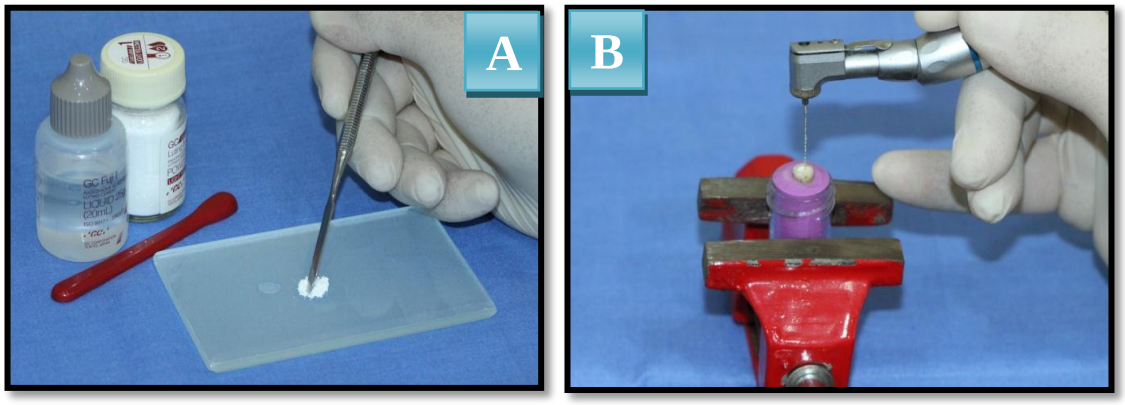

Figure 4: GC Fuji I cementation: (A) Mixing GC Fuji, I cement (B) Spreading the cement by lentulo spiral

:Decalcification Dye penetration and

The roots were covered with two layers of nail varnish with aid of brush by grasping the roots by tweezers. The nail varnish was applied except for 2 mm of the coronal orifice (Figure 5). After that, each root was separately place in coded glass vial which contained 10% Indian ink solution left at room temperature for 72 hr. (Figure 6). 10% Indian ink dye was prepared by adding (10 g) of Indian ink particle to (90 ml) distilled water, after that shacked and mixed to facilitate dissolution of Indian ink particles. During this period each vial was shaken every 6 hr. to allow all surfaces of the root to be available to the dye solution. After this period, the roots were removed from the dye and washed under tap water; the nail polish was removed from the surface of the roots using acetone solution and surgical blade no.11 then dried in a dry place for 24 hr. as recommended by Rahimi et al.[15]

The teeth decalcified and cleared according to the method described by Fox & Gutteridge.[16] The roots were decalcified by placing them in 5% nitric acid for three days. Five percent nitric acid was prepared by adding 7ml of (70%) nitric acid to 93 ml of distilled water (Figure 7). The prepared nitric acid was added to each vial and the vials were shaken every 6 hr. to allow all surfaces of roots to become decalcified and the nitric acid was changed daily. The end point of decalcification was determined by head of sharp probe which can penetrate the root, as described by Ravanshand & Al-Khayat.[17]

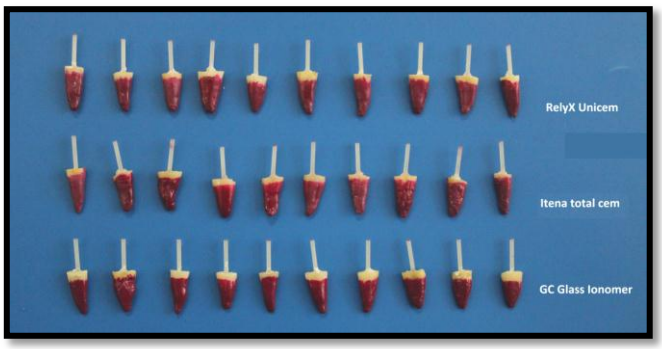

Figure 5: The roots covered with nail varnish

Figure 6: Coded glass vial which contained India ink

Figure 7: Coded glass vial which contained root & nitric acid

Dehydration and Clearing:

After the roots became decalcified, they were washed under running water for four hr., (to remove any trace of nitric acid). Then the roots and vials were dried and each root was replaced in their vial. Dehydration was done by adding ascending grades (80%, 90%, 95% and l00%) of ethyl alcohol to the roots in the vials. To prepare 80% ethyl alcohol solution, 80ml of absolute ethyl alcohol was added to 20ml of distilled water and in the same way 90% and 95% of alcoholic solutions were prepared by adding 90ml and 95ml of absolute alcohol to 10ml and 5ml of distilled water respectively. Firstly 80% ethyl alcohol was added to the vials for 12 hr., and then the solution in the vials was removed. Then prepared 90% alcohol was added to samples and remaining in it for one hr., after this time the solution will be changed and the prepared 95% alcohol was used also for one hr. Finally absolute (about 100% ethyl alcohol) was added to the samples which were also maintained in it for another one hr. Finally, the roots were made transparent by immersion in methyl salicylate. After three hour the roots become transparent. The roots were

stored in the clearing solution till the time of examination under stereomicroscope.

Stereomicroscopic Examination:

Two independent inspectors used the stereomicroscope ST-39 (MOTIC, Deutschland GmbH, Germany). to analyse the coronal dye penetration (eye lens 10X, objective lens 4X). The samples were divided into groups that were examined at two different times with fourteen days between them for the identification of maximum dye penetration (Figure 8). The dye penetration was calibrated using a graded lens with lines having 0.16mm distance between them. Each surface of the roots was viewed using a slide that was placed in a stereomicroscope for inspection. The slides holding the roots were rotated to see each surface.[17] Multiplication was conducted using 0.16 and the number of lines to attain the dye penetration measurements within millimeters. The findings were gathered and examined through the application of SPSS software version 21.0. This research used the One-Way Analysis of Variance to examine any statistically noteworthy diversity amid the groups. Moreover, the Honest Significant Difference of Turkey was applied after the various comparisons assessment to evaluate among the groups once the One-Way Analysis of Variance was conducted.

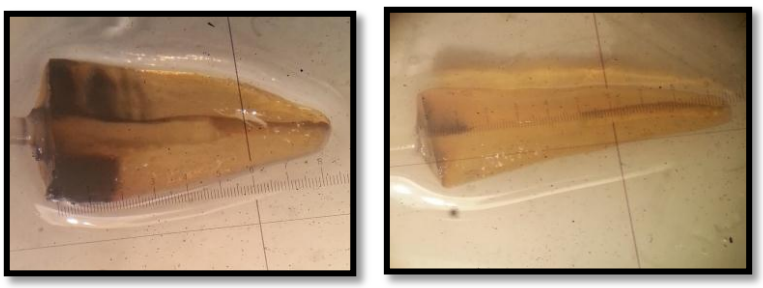

Figure 8: Steriomicroscobic examination of cleared sample code 18 & 21

Result

Descriptive statistics of micro-leakage value of fiber post with three different types of luting cement are shown in (Table 2), which shows that TotalCem has the lowest value of micro-leakage, followed by RelyX Unicem while GC Fugi I has the highest mean.

Table 2: Descriptive statistics of micro-leakage of fiber post with different type luting cements

Luting Cement	N	Minimum	Maximum	Mean	St. Deviation
RelyX Unicem (Dual-Cure)	10	1.60	4.80	3.1160	±0.90950
TotalCem (Dual-Cure)	10	.80	3.68	1.9680	±0.87976
GC Fuji I (Self-Cure)	10	2.56	7.36	5.5440	±1.86592

One-way ANOVA (Analysis of Variance) for comparison between all luting cements is described in table (Table 3)**,** which shows highly significant differences between luting cements.

Table 3: One-way ANOVA for micro-leakage test for luting cements

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	66.670	2	33.335	19.675	.000
Within Groups	45.745	27	1.694		
Total	112.415	29			HS

Tukey's HSD was performed to differentiate between each two-luting cement. It showed the significant difference between RelyX Unicem and GC Fuji I. Also, significant differences exist between TotalCem and GC Fuji I, while there was no significant difference between TotalCem and RelyX Unicem.

Discussion

Failure of the endodontics is mainly affected by the existence of bacteria in the canals of the roots affected by imperfect formulation of root canals or infection from a weak coronal cover.[18] In teeth that are treated endodontically, the absence of coronal structure of the tooth usually requires the setting of a core and post to give retention to the crown. Additionally, the post should support the hermetic coronal cover as well. A hindering issue in the success of treatment is the microleakage that happens when the seal has breakage.[19]

The difference among extracted teeth and in vivo dentition could affect leakage. This includes the absence of hydrostatic pressures that are physiological, reduced oxygenation of tissues, and reduced temperature of the tooth. An additional difference between the initiation of leaks and real clinical leaks is the movement of the products that are utilized to calculate the level of leakage in comparison to the movement of bacteria that are clinically related. Lastly, the level of leaking that represents a clinically undesirable scenario is unclear; additional variables, including patient immune reaction variance, would contribute differences to any crucial leaking standards. Indeed, based on differences in experimental settings and an absence of procedure standards, these types of research are not totally and accurately comparable.[20] In root canals, micro-leakage is challenging because several factors can play a role, including the size and structure of the root canal, methods for filling the root, irrigating solutions, chemical and physical aspects of the seal, and the canal's infectious condition.[21]

Because of the absence of standard samples and methods, there exist issues with research on in vitro coronal micro-leakage. In this study extracted human teeth were used to enhance the reliability of the investigation by duplicating the clinical situation, and each of the canals was formed with equivalent sizes (#F3). It was attempted to form the teeth samples equivalent by choosing teeth with one root and one patent root canal in order to reduce variances in structure and enable standardization and prevent issues of several canals.

Clearing and decalcification were utilized, in this study, and chosen instead of sectioning since the technique of inspecting teeth that were cleared for penetration of ink underneath a dissecting microscope demonstrated to be a suitable method for examining leaking of ink in three aspects without damaging the root sample.[22] The traditional sectioning technique of the specimens were related to the damage of part of the tooth because of the thick blade and method of sectioning; therefore, the precision of the degree of ink penetration was affected.[23]

Examining the teeth underneath the dissecting microscope revealed the patterns of leaking throughout the tooth, with only the greatest amount of dye penetration measured. The strong difference between the pink gutta-percha substance and the black India ink in this investigation made the leaking patterns very obvious, and linear penetration was simple to evaluate using a micrometric lens.[17]

The outcomes of the current study indicated, in stereomicroscopic assessment, that the increased degree of micro-leakage in the group sealed with GIC might be due to decreased adhesion between the root dentin and material[24]. Furthermore, there

was no significant difference in micro-leakage between TotalCem and RelyX Unicem groups. The RelyX Unicem presents a micro-leakage value higher than the TotalCem; however, the difference was not significant.

In comparison with mono-methacrylate monomer, UDMA was the most commonly utilized cross-linkers. They are generally distinguished by hydrophobic action, which means they are only partially soluble in water. However, because of the hydroxyl groups and/or polar ether-linkages, some water adsorption is unavoidable.[25] UDMA has a considerable impact on the viscosity of the uncured adhesive resin, and UDMA has reduced viscosity qualities.[26]

Because UDMA is among the key components of TotalCem, the reduced level of leaking could be due to the cement's reduced viscosity and the RelyX Unicem's greater viscosity, which restrict their absorption into microscopic porosities. Polymerizing resin cement that is slow might aid in relieving polymerization shrinkage pressure because of the movement of resin.[27] This explains how TotalCem had a greater sealing effect than RelyX Unicem, which was due to TotalCem's lower viscosity. The findings of the study indicated that GIC cement demonstrated the greatest mean micro-leakage degree in comparison with TotalCem and RelyX Unicem, and it was significantly different.

The GICs adhering mechanism to the dental hard tissues is difficult and might not be the same for RM-GICs. An ionic bond takes place among the carboxyl ions with the cement and the calcium ions within the dentine and enamel. When newly prepared traditional GIC is applied to enamel or dentine, any smeared coating dissolves, but demineralization is minor because the acid is buffered by the tooth hydroxyapatite, and the polyalkenoic is fairly weak.[28] In GIC, interdiffusion is impossible, and the reaction of setting is mainly an acid-base reaction that enables it to chemically bond to the substance of the tooth. This process happens through the carboxyl group chelation of the acid within the GIC with the ions of phosphate and calcium existing in the dentine and enamels apatite.[29]

The outcomes might have been likewise affected by the diversities within the manner of usage. The GC group has a risk of void inclusion to occur while combining liquid and powder substances to place it within the root canals using the lentulo spiral. It is likely for the whole area of the root canal to experience luting substance inhomogeneous distribution; however, auto-mixing method is implemented by others. The method with the greatest suitability might be the use of centrix syringes to position the cement because it likely stimulates the cement layer to have a reduced amount of cracks and bubbles.[1]

Additional components may center on the fairly brief time provided to work with the self-cured luting cement. The dual-cured and light-cured materials provide more time to be able to work using them than the self-cured luting cement. The cases that may need an adequate range of time to work with the cement may encounter a reduction regarding the self-cured cement's flow, for instance, the root canal undergoing post luting within it. This could lead to the root canal's deep section not being closed with cement properly.[30]

Conclusion

Within the limitation of this study, it was found that each luting cement used in this study produced microleakage. TotalCem produced the least amount of microleakage while GC Fuji I luting cement produced the highest value.

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