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An In Vitro Microleakage Evaluation of a New Cold Flowable Gutta-Percha Based Sealer

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Abstract

Aim: The aim of this study is to evaluate the microleakage of a new cold flowable silicone based sealer after application to the root canals by different obturation techniques using bacterial leakage method.
Materials and Methods: In our study 100 single rooted maxillar incisor teeth were used. Teeth were caries free and have straight canals and fully matured apexes. Teeth were divided into four experiment (20 teeth) and two control (10 teeth) groups after decoronated from CEJ. All teeth in experiment groups were root filled by using GuttaFlow due to the manufacturers manuel and then observed for bacterial leakage for 60 days. Leakage ratios compared between groups.
Results: In our study Group l (GuttaFlow canal tip and single cone technique) showed least leakage and Group lV (lentulo and lateral condensation technique) showed most leakage amongst all groups. Also according to the speed of leakage, Group l was the slowest and Group lV was the fastest amongst all groups. The rate of bacterial leakage was analysed statistically using Fisher's Exact Chi-Square Test. The speed of bacterial leakage was analysed statistically using Kaplan-Meier analyse and Log-Rank Test.
Conclusions: GuttaFlow shows adequate resistance to bacterial leakage if used under the directions of the manufacturer and applied by a canal tip and single cone technique. Considering the sealing abilities, GuttaFlow can be a good alternative to existing root canal sealers.

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Keywords: GuttaFlow, bacterial leakage, lateral condensation, single cone, obturation.

Introduction

To obtain success in endodontics, totally cleaning the root canal system from infected or necrotic pulp tissue and microorganisms and firmly obturation of the canal space is mandatory (1-3). To protect the root canal system from recontamination by the remaining microorganisms after chemomechanical preparation or by the microorganisms which can leak from coronal or lateral canals, performing adequate obturation is very important. Root canal filling should eliminate the remains of microorganisms and show good adaptation to the root canals to not allow microorganisms and their products into the root canal system (4).

When microorganisms pass through apex to the periapical tissues they can cause bone destruction (5). Hermetically sealed root canal prevents nutrition of residual microorganisms by blocking coronal leakage and infiltration of periapical liquids. So root canal obturation is pivotal on controlling and preventing endodontic infections (6).

To date its shown that there is a strong correlation between the prevalance of post treatment apical periodontitis and poorly fillied root canals and unadequate coronal restorations (7).

For decades' lots of obturation techniques used to seal root canals. The technological progressions about root canal obturation are based on the main idea to hermetically sealing the root canals (5). Microleakage can occur through dentin-guttapercha, dentin-sealer and sealer-guttapercha interfaces (8). Also polimerisation shrinkage and dissolution by the time at sealer mass can cause microleakage (9,10). But main gutta-percha mass is leakageproof (11). Taking these data into acoount obturation techniques should depend on to maximize the gutta-percha mass and minimize the sealer amount (12).

Until today more than 100 different obturation techniques have been used to seal root canals (13). Lots of these techniques use a core material and a sealer together. Independently from the core material, the sealer is the essential element of the obturation and it should obtain a totally leakeproof blockage (14).

The ideal root canal sealer should not only be able to kill the residual bacteria on the dentinal wall but also should be able to eliminate the bacteria in the dentinal tubules. To provide this antibacterial property of the sealer is not enough alone without the penetration capability into the dentinal tubules. Because of this fact, the antibacterial properties of a root canal sealer shouldn't be evaluated without taking into account of the flowability and penetration capability of the sealer (15).

The purpose of this study is to evaluate the sealing abilities of GuttaFlow which is a newly produced silicone based sealer, after applying to the root canal by using different obturation techniques. The null hyphothesis of this study is application technique of GuttaFlow has no effect on bacterial microleakage.

Materials and Methods

In our study 100 single rooted maxillar incisor teeth were used. Teeth were caries free and have straight canals and fully matured apexes. All of the roots were prepared by ProFile .06 30, .04 30, .04 25 rotary instruments (Dentsply Tulsa Dental, USA) using a crown-down technique under the directions of the manufacturer. After each instrument 2 ml 2.5% sodium hyphochlorite (Wizard, Rehber Kimya, Türkiye) used to irrigate root canals. All samples divided into four experimental group of 20 and two negative and positive control group of 10 (Table1). In all experimental groups GuttaFlow (Coltène/Whaledent, Altstätten, Switzerland) root canal sealer was used. GuttaFlow was prepared under the directions of the manufacturer. All obturated root surfaces except apical and coronal parts were sealed with nail varnish to obtain leakageproofness.

Table 1. Root canal filling techniques according to groups.

Group I	GuttaFlow canal tip and single cone technique
Group II	Lentulo and single cone technique
Group III	GuttaFlow canal tip and lateral condensation technique
Group IV	Lentulo and lateral condensation technique

Teeth were placed into the Eppendorf tubes as their apical part passes through the cutten down part of the tubes. Cyanoacrylate was used to seal the surface between the root and the tube to guarantee impermeability. This system was placed into a sterile glass tube full of brain heart infusion (BHI) medium after making it pass through a lastic gasket. Enterococcus feacalis (ATCC 29212) bacterial suspension was placed into the Eppendorf tubes which were prepared from Mc Farland 1 chart in a 18-24 hour period. Every 3 days, bacterial suspension changed with fresh suspension. Every 24-hour turbidity was observed in the medium for 60 days.

When turbidity was observed, that day was recorded as the leakage day for that sample. Microleakage ratios of different groups were compared by using Fisher's Exact Chi-Square Test. The speed of bacterial leakage was analysed statistically using Kaplan-Meier analyse and Log-Rank Test. Also leakage speed for 15, 30, 45 and 60 days are calculated. For $p < 0.05$ the comparasions were accepted significant.

Results

Results of bacterial leakage test

In our study we have investigated the sealing abilities of GuttaFlow using a bacterial leakage test. Totally, 80 samples divided randomly to four experiment groups. Also two groups of 10 samples were used as positive and negative control to test the reliability of the experiment desing. In negative control group no turbidity was observed during the 60 days' period. Adversly, in positive control group, turbidity was observed at all of

the samples after the first 24 hours. If all of the experimental groups taken into account, leakage have been observed between 3. and 59. days. In Group l only one sample showed leakage at the 56. day. In Group ll five samples between 24. and 59. days, in Group lll ten samples between 14. and 56. days and in Group lV eleven samples between 3. and 38. days showed leakage(Table2).

Table 2. Distribution of days with leakage according to groups.

Days	Group I (n:20)	Group II (n:20)	Group III (n:20)	Group IV (n:20)
Day 3				1
Day 11				2
Day 14			1	1
Day 15			1	
Day 19				2
Day 20				1
Day 21			1	
Day 23				1
Day 24		1		
Day 25			1	2
Day 26			1	
Day 33			1	
Day 35			1	
Day 36			1	
Day 38				1
Day 41			1	
Day 45		1		
Day 52		1		
Day 55		1		
Day 56	1		1	
Day 59		1		
Total	1	5	10	11

Totally, 53(66,25%) samples didn't show leakage after the 60 days' period but 27(33,75%) samples showed leakage. After the 60 days' observation period leakage percentage of the groups are 5% in Group l, 25% in Group ll, 50% in Group lll and 55% in Group lV respectively (Table 3).

By applying statistical analyse to the data of time period without leakage, expected time without leakage have been determined. In Group l expected time without leakage is calculated as 60(59-60) days. In Group ll 57(53-60) days, Group lll 45(38-53) days and Group lV 37(28-47) days have been calculated as expected time without leakage. Considering all of the experiment groups expected time without leakage have been calculated as 50(46-53) days (Table 4).

Table 3. Number of samples showing leakage according to groups and leakage rates.

Groups	Number of samples	Number of samples showing leakage	Leakage rates(%)
Group I	20	1	5
Group II	20	5	25
Group III	20	10	50
Group IV	20	11	55
General	80	27	33.75

Table 4. Expected time without leakage.

	Expected time without leakage (Day)
Group I	60 (59-60)
Group II	57(53-60)
Group III	45 (38-53)
Group IV	37(28-47)
General	50(46-53)

Multiple Comparisons

Differences between the leakage percentages between each group have been compared by Fisher's Exact Chi-Square Test (Table 5).

Table 5. Multiple comparison results between groups according to leakage rate.

Multiple comparison	Leakage rate	
	Chi-square	P*
Group I – Group II	-	0.182
Group I – Group III	10.16	<0.001
Group I- Group IV	11.90	<0.001
Group II-Group III	2.67	0.102
Group II-Group IV	3.75	0.053
Group III-Group IV	0.10	0.752

* Fisher's Exact Chi-Square Test ($p<0.05$)

Changes in the leakage speed at different groups have been calculated using Log Rank test and Kaplan Meier Analyse (Table 6).

Table 6. Multiple comparison results between groups according to leakage speed.

Multiple comparison	Leakage speed	
	Log-Rank	P*
Group I – Group II	3.18	0.075
Group I – Group III	10.68	<0.001
Group I- Group IV	12.60	<0.001
Group II-Group III	3.48	0.062
Group II-Group IV	5.42	0.050
Group III-Group IV	0.58	0.448
* Fisher's Exact Chi-Square Test ($p<0.05$)		

In our study, the least number of leaked samples was at Group l and the most was Group lV. When leakage speeds compared, Group l was the slowest and Group lV was the fastest.

Discussion

Brackett et. al. applied GuttaFlow into the root canals using four different techniques (16). In Group l, a GuttaFlow coated gutta-percha cone was moved upwards and downwards two times then placed apically, in Group ll, a GuttaFlow coated gutta-percha cone was inserted into the root canal and rotated counterclockwisely then placed apically, in Group lll, a GuttaFlow coated gutta-percha cone was placed apically without doing anything else and in Group lV, GuttaFlow applied into the root canal by canal tip without a gutta-percha cone. Fluid filtration method was used to determine the amount of leakage. The most leakage was observed at Group lll and the least leakage was observed at Group lV. This study was disproved the hyphothesis that application technique of GuttaFlow has no effect on microleakage and showed similarities with our study.

Film thickness of root canal sealers have adverse effect on their sealing abilities; when the thickness increases, paralelly amount of leakage rises (17). The increased amount of root canal sealer as a result of using a single cone technique causes more polimerisation shrinkage and microleakage (18). In previous studies it has been observed that GuttaFlow does not shrink during polimerisation but also slightly expands (19,20). In the same line with these studies, in our study Group l and ll which have more amount of GuttaFlow than Group lll and lV showed less microleakage. We think this was a result of the expansion ability of GuttaFlow during polimerisation.

During root canal obturation interfaces be formed between sealer and gutta-percha, sealer and dentine, gutta-percha and dentine through which microleakage can occur. When GuttaFlow used with a single cone, interfaces decrease and as a result microleakage decreases (16). This may be another reason of greater amount of microleakage at Group lll and lV than Group l and ll in our study.

Although the working time of GuttaFlow was declared as 10-15 minutes by the manufacturer, AlAyouti et al. (2005) reported that its working time is 8 minutes (21). We think that short working time of GuttaFlow influenced the higher microleakage amount of Group lll and lV in our study by preventing the sealer's penetration through the dentinal tubules during lateral condensation procedure.

In a study in whichh AlAyouti et al. (2005) examined the homogeneity of GuttaFlow, has been found that GuttaFlow coated the dentinal walls but there was a high number of small voids in the body of sealer. They connected this situation with the application of GuttaFlow into the canals by using lentulo spiral (21). In our study there was no statistical significant difference between Group l and ll but the amount of the microleakage was higher at Group ll. This can be explained with different application methods of GuttaFlow in this two groups. In Group l usage of canal tip might be reduced the amount of microleakage also in Group ll usage of lentulo might be increased the amount of microleakage. Between Group lll and Group lV there was no statistically significant diffence also the amount of leakage at two groups are very close numerically. This can be explained with the usage of lateral condensation technique. We think lateral condensation eliminated the small voids that created by lentulo.

In a bacterial microleakage study of De-Deus et al. (2007), the root canals were obturated with GuttaFlow and then observed for 9 weeks. The total microleakage ratio was 15%(17). In that study GuttaFlow applied to the root canal by a counterclockwise rotating #40 K File and the technique choosen for obturation was lateral condensation. In that study the source used for bacteria was human saliva (17). We see the reason for the greater amount of microleakage in our study than the study of De-Deus et al. (2007) as the diffence of the species and amount of bacteria used in both studies.

The expected time without leakage observed in our study is similar to the study of Eldeniz and Ørstavik (2009) in which they applied GuttaFlow into the canal by lentulo and used a single cone technique (22). Eldeniz and Ørstavik (2009) reported that 60% of the samples did not showed leakage after a time period of 40 days (22). In our study if we take into account the first 40 days' period 75% of the samples did not showed leakage.

Savariz et al. (2010) conducted a study in which they obturated the root canals with three different methods. Single cone and lateral condensation technique was used for obturation. In another group GuttaFlow used for obturation alone. Dye penetration test was conducted coronally and apically to all samples. The single cone group showed less amount of leakage and GuttaFlow without master cone group showed the most amount of leakage. There was no statistically significant difference between the single cone and lateral condensation group. But both groups showed statistically significantly less leakage than the group without a master cone (23). This results are similar to the results of our study.

In a glucose filtration study which is conducted by Özok et al. (2008) has been observed a leakage ratio of 70% at the GuttaFlow group after an observation period of 4 weeks (24). In our study this ratio was found as 5%. Pommel et al. (2001) compared liquid filtration, electrochemical and dye penetration techniques for their performance to determine microleakage and they reported there was no correlation between the results of different microleakage tests (25). We think that the difference between our study and the study of Özok et al. (2008) can be explained by the use of different methods to determine microleakage.

Prithviraj et al. (2020) used E. Feacalis as microleakage indicator in their study similar to our study and they reported superior sealing abilities of GuttaFlow(26).

In our study Group l showed the least amount of microleakage after 60 days period of observation in which GuttaFlow was applicated to the root canals by a canal tip and used with a single cone technique. The most amount microleakage after 60 days period of observation in which GuttaFlow was applicated to the root canals by lentulo and used with lateral condensation technique.

Conclusions

The null hyphothesis of this study that the application technique of GuttaFlow has no effect on bacterial microleakage was disproved. Different application methods affected the resistance of GuttaFlow to bacterial microleakage at different rates.

Finally, GuttaFlow shows adequate resistance to bacterial microleakage if used under the manufacturer's instructions; using a canal tip and single cone technique. Considering the sealing abilities, it can be seen as a good alternative to the actual root canal sealers. Especially, the loss of coronal restoration may lead to necessity of retreatment in few cases than other root canal sealers due to long expected time period without leakage of GuttaFlow.

When the fact that different methods of leakage determination leads different results evaluated, there is necessity to further investigation on the sealing abilities of GuttaFlow.

Descriptions

Author Contribution

Study conception and design: THE, LZ
Analysis and interpretation of the data: THE
Draft manuscript preparation: THE
Critical revision of the work: LZ

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