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Evaluation of Sealing Ability of Three Different Sealers, Bioroot RCS, Guttaflow II, AH Plus - An in-Vitro Study

Hemalatha Paranthaman[1], Priyadharshini Theetharappan[2]

[1]Proffessor and Head of the Department, Department of Conservative Dentistry and Endodontics, Best Dental Science College, Madurai, Tamilnadu

[2]PG student, Department of Conservative Dentistry and Endodontics, Best Dental Science College, Madurai, Tamilnadu

Abstract: ***This in-vitro study compared the sealing ability of three different sealers Bioroot RCS, Guttaflow II and AH Plus using glucose leakage model. The study was done on 45 extracted single rooted human mandibular premolars. The teeth were decoronated and instrumentation was done till size F3 using Protaper rotary universal system. The specimens were randomly divided into three groups based on the sealers used. All the specimens were obturated with F3 single cone and the sealers were placed using the master cone. Group A – single cone with Bioroot RCS, Group B – single cone with Guttaflow II, Group C – single cone with AH Plus. All samples were incubated for 1 week and microleakage measurement were made using glucose leakage model at an interval of 1 day, 1 week, 2 week and4 week respectively. To compare the mean leakage values between the groups, repeated measures ANOVA followed by Tukey's HSD post hoc test were used. The three experimental groups showed significant difference in the leakage values at all test periods (p=0.05). At the end of 1 day, Bioroot showed better sealing ability followed by AH Plus and Guttaflow II. At all other time periods, Bioroot RCS had better sealing ability followed by Guttaflow II and AH Plus. At the end of experimental time period, it is concluded that none of the sealer provided complete seal but Bioroot RCS provided superior sealing ability compared to Guttaflow II and AH Plus.***

Keywords: AH plus,Bioroot RCS, Guttaflow II, glucose leakage model, sealing ability

1.Introduction

Success of root canal therapy depends on complete elimination of pulp tissues and the infection causing micro-organisms through debridement of the canal.From a biological perspective this involves the removal of the organic material which can decompose to tissue-destructive products or which can promote the bacterial growth. In addition to this, a mechanical preparation of the root canal space which allows for complete obturation with a biocompatible material that will seal the apical end of the root canal as close as possible to the cemento-dentinal junction is also necessary.

Though the chemo-mechanical preparation is essential, the goal of the endodontic procedure should be to provide a hermetic seal that prevents re-infection of the root canal system. To achieve such a seal, it is necessary to seal all the portals of entry for the micro-organisms. Therefore the obturation acts a barrier to infection or re-infection of both root canal system and the peri-radicular tissues[1].

Gutta- percha has remained the choice of root canal obturation for the past century and more because of its high biocompatible nature. While "guta-percha root fillings" remained the common term, it was realised that in the absence of root canal cement, such root fillings were frequently associated with clinical and radiographic signs of apical periodontitis[2]. Hence the root canal sealers used in conjunction with the gutta-percha or other solid cones should provide a homogenous root filling. Sealer plays an important role in the success of the endodontic therapy by filling the irregularities and minor discrepancies between the root canal wall and the core filling material.[3,4] Inadequate sealer placement may result in formation of voids and excess placement will result in extrusion of sealer beyond apex which will delay healing.

Most sealers have the property of dissolving over time. This property of dissolution can lead to failure at the sealer dentin interface or the sealer-core interface and cause micro-leakage at these areas leading to failure of the root canal treatment[6].In order to overcome such a difficulty, sealers that has thecapability of reinforcing the root canal, less solubility and that formsmonoblock has been introduced. Recently a new class of bio-ceramic material have been introduced that aim for the hermetic seal of the root canal system in a more biologic approach. The tricalcium based sealers have a property of reacting with the tissue fluids when in contact with it and resulting in the formation of calcium hydroxide at the sealer and dentin interface thus reducing the chances for micro-leakage[6].

A wide variety of test are used for evaluating the efficacy of seal of the endodontic materials including, dye leakage, fluid penetration, radio-isotope method, bacterial leakage model. The lack of standardization, varied results leads to identification of a new methodology - glucose leakage model which is more meaningful and more clinically relevant[7].

In 2005, Xu et al discussed a new model that allows the measurement of leakage of glucose molecule through the root canal using a spectrophotometer.

Hence the aim of this present study was to evaluate the sealing ability of three sealers, Bioroot RCS, Guttaflow 2

and AH Plus based on the glucose filtration along the root canal filling material.

2.Material and Methodology

Forty five extracted mandibular premolars were included in the study. The surface of the root was cleaned of the debri using ultrasonic instrument. The samples were stored in 0.2% sodium azide solution until use to prevent bacterial growth. Radiographs were taken to ensure that there were only single canal in all teeth.Standardization for the length of the samples were done by decoronation to a length of 16mm using a diamond disc at slow speed under copious water irrigation.

The working length was established by using a #15 k file(Mani Inc, Tochigi, Japan) until it was visible at the apex and the working length was established 0.5mm short of this length. The biomechanical preparation was done using protaper universal rotary files upto size F3(Dentsply, Maillefer,Langenau, Germany, Switzerland) using a crown down technique. The canals were irrigated with 5ml of 3% sodium hypochlorite solution with a 27-gauge needle after each instrument. After the instrumentation, the canals were irrigated with 17% EDTA followed by 10ml of distilled water as a final rinse.

All the samples were obturated by using single cone technique. Based on the three different sealers used the samples were assigned to three groups. For standardization, all the canals were obturated with F3 gutta-percha cone being the master cone.The sealer was mixed according to the manufacturer instructions and it was coated in the canal wall using the master cone. The cone was taken out of the canal and coated again with the sealer and then placed into the canal.

Group A: F3 single cone with Bioroot RCS sealer (Septodont, Saint Maur-des-Fosses, France)
Group B: F3 single cone with Guttaflow II sealer(Coltene/Whaledent, Langenau, Germany)
Group C: F3 single cone and AH Plus sealer (DentsplyMaillefer, Ballaigues, Switzerland)
The coronal orifices of all the samples were sealed by using a heated plugger. All the samples were incubated at 37°C and 95% humidity for 1 day to ensure complete setting of the sealer.

The micro-leakage measurement was done by glucose leakage model. This model was setup according to the procedure described by Xu et al.

The surfaces of the roots were covered with two coats of nail varnish leaving the coronal 2mm and the apical 3mm. The coronal 2mm of the roots were connected to a rubber tube of 2cm long and the other end of this tube was connected to a 17cm long glass tube. Both the connection sites were sealed using cyanoacrylate and sticky wax to ensure zero leakage at this interface.

This assembly was then placed into a 15ml sterile glass test-tube with a screw plastic cap through which the glass tube was passed. 0.2% of 3ml of sodium azide solution was dispensed into the glass test tube provided that the apical 3mm of the root specimen was immersed into this solution. 2.5ml of 1mol/L glucose solution was dispensed into the glass test tube until the top of the solution was 14cm above the gutta-percha in the canal. This would create a hydrostatic pressure of 1.5kPa (15cm of H_2O). The glucose solution that passed through the obturatedcanal was collected in the sodium azidesolution to inhibit the proliferation of micro-organisms that might decompose the glucose solution.(*Fig 1*)

The glucose solution used as a tracer in this study has a concentration of 1mol/L and it has a molecular weight of 180Da. All the sample models were placed in incubator at 37°C and 95% humidity all the time during the observation period.The micro-leakage measurement is done by taking 0.5ml of 0.2% sodium azide aliquot solution from the glass test-tube and subjecting it to spectrophotometric analysis for the measurement of concentration of glucose. Each time the aliquot solution is taken, a fresh solution of 0.5ml of 0.2% sodium azide solution was added to the test-tube to maintain the volume of 3ml. The micro-leakage measurement was made at 1day, 1, 2 and 4 weeks respectively.

Figure 1: Glucose leakage model setup

3.Statistical analysis

To compare the mean values between groups repeated measures ANOVA was applied followed by Tukey's HSD post hoc test. To analyse the data SPSS (IBM SPSS Statistics for Windows, Version 23.0, Armonk, NY: IBM Corp. Released 2015) was used. Significance level was fixed as 5% ($\alpha = 0.05$).

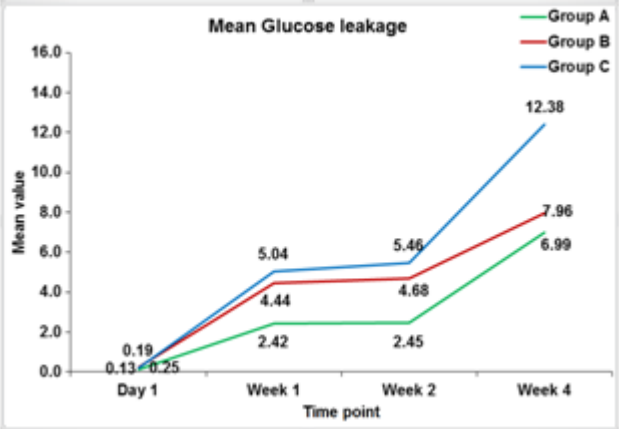
4.Results

The mean values and statistical comparisons between the experimental groups at each time interval are given in Table 1. At day 1, the mean glucose leakage was the lowest for group A followed by group C and group B. Though the mean glucose leakage values continued to increase over time period for all the groups, Group A continued to possess least leakage value compared to other two groups at week 1, week 2 and week 4. At week 1, the mean glucose leakage value was least for Group A followed by Group B and Group C. At week 2, the mean glucose leakage value was least for Group A followed by Group B and Group C. At week 4, the

mean glucose leakage value was least for Group A followed by Group B and Group C

Table 1: Comparison between glucose leakage mean values (mg/dl) of each group at specific time intervals

Glucose concentration (mg/dl) (mean ± standard deviation)				
Groups	Day 1	Week 1	Week 2	Week 4
Group A	0.13±0.06^{a}	2.41±0.44^{a}	2.44±0.17^{a}	6.99±0.21^{a}
Group B	0.25±0.02 ^{a,b}	4.44±0.37 ^{b}	4.67±0.13 ^{b}	7.95±0.19 ^{b}
Group C	0.19±0.11^{a,b}	5.03±0.47^{b}	5.45±0.31^{b}	12.38±0.34^{c}



Tukey HSD post hoc test: means with the same superscript values within the same column are not statistically significant at $p<0.05$

5.Discussion

The main objective of the root canal therapy is to obturate the root canal system and create an impervious apico-corono seal. This is achieved by the use of a solid or a semisolid core material and a sealer. A core alone fails to provide the necessary seal of the root canal system. Hence, sealers with different properties are used that could provide a hermetic seal[8].

In the present study, single rooted teeth with single patent canals were used to minimize the variations in the canal anatomy that could possibly affect the results. The canal diameter was enlarged to a standard size of 30/0.09% and the root length was standardized to 16mm to standardize the samples. It has been described previously by V.H.Nunes et al that the root canal seal improved with the removal of smear layer before obturation[9]. Hence 17% EDTA was used for the removal of smear layer in this study.
Despite the various advantages of the conventional Gutta-percha points and sealer obturation, there are several disadvantages like its inability to adhere to the dentin, the solubility of the sealer and hence the micro-leakage of the root canal filling which makes the prognosis a questionable one[10]. So the need to find alternatives that could reinforce the weakened tooth structure by the formation of monoblock, lead to redeposition of apical matrix thereby aiding with healing of apical tissues led to the development of newer sealers.

This study aimed at evaluating the sealing ability of contemporary sealers bioroot RCS and Guttaflow II with AH plus, which is considered as the “gold standard” because of its properties co-relating with the ISO standards[11].

Various methods are being used for the assessment of sealing ability.Glucose leakage model was used in this study because it is sensitive, non-destructive and clinically relevant. It could be clinically co-related in a way that glucose having a low atomic weight could easily pass through the irregularities of the obturated root canal. And if glucose could pass through the irregularities present then it could provide the nutrition for the remnant bacteria that has survived the root canal instrumentation and it could lead to the failure of the root canal treatment[11].

In this study it can be seen that the Bioroot RCS group possessed greater sealing ability compared with the Guttaflow II and AH Plus at all time periods. This is in accordance with the study by Viapana et al where he compared the sealing ability of Bioroot RCS and AH Plus and proposed that Bioroot RCS showed a better sealing ability[12]. Bioroot RCS is a bioceramic sealer that is composed of tricalcium silicate and zirconium oxide. It is proposed that the amount of calcium that leaches from Bioroot RCS is double the calcium that leaches from a similar kind of bio-ceramic sealer, EndosequenceBC sealer[13]. These calcium ions on contact with the physiological fluids form a calcium phosphate phase forming a mineral infiltration zone between the sealer and the root canal dentin. This zone helps in the biomineralisation activity of the sealer[12]. Thus this sealer exhibits its higher sealing property.

In this study Guttaflow II showed higher leakage compared to AH Plus at the end of 1 day. This is in accordance with the study done by Ozok et al. The reason the authors speculated that this thixotropic sealer could flow under the pressure applied by the inserted gutta-percha cone leaving only the gutta-percha particles between the cone and the dentinal wall leading to inferior seal[16].In this study also sealer was applied using master cone. Hence this could possibly be the reason for higher leakage of Guttaflow IIin this study at the end of 1 day. The improvement in the sealing ability of Guttaflow II at the subsequent days could be possibly because of the 0.2% setting expansion of the sealer[17].

AH Plus is an epoxy resin based sealer that sets by polyaddition reaction of the diamines present in its composition. In this study it is shown that the sealer possessed a gradual increase in the leakage values over time. This is in accordance with the study done by Patilet al[17]. AH Plus though it had superior sealing ability at the end of day 1, it is thought that they react with any exposed amino groups in the collagen to form covalent bonds between resin and collagen when the epoxide ring opens. This could have led to further gap at the interface and inadequate bonding between sealer and gutta-percha, allowing fluid to pass as suggested by Tay et al[18].

6.Conclusion

Within the limitations of this study it could be concluded that,

- None of the sealers provided complete sealing at all time periods
- Bioroot RCS showed superior sealing ability followed by Guttaflow II and AH Plus.

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