An in vitro evaluation of Sealing ability of newly introduced C Point as an obturating material: A glucose leakage model study

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Abstract

AIM: To evaluate and compare the sealing ability of newly introduced C Point and Protaper Gutta Percha

MATERIAL AND METHODOLOGY: A total of 30 freshly extracted human mandibular second premolar was selected, and their crowns were cut. The root canal of each sample was instrumented using a rotary crown down technique and then divided into two experimental (n = 10 each) and one control group (n = 10). Samples in the experimental groups were filled as follows: Group 1, Protaper Gutta Percha; group 2, single-cone C-points/ Endosequence bioceramic-sealer; group 3, control group after 7 days, the sealing ability of root canal fillings was tested at different time intervals using glucose leakage model. Glucose leakage values were measured using a spectrophotometer and statistically analyzed.

Results: The control group showed no detectable glucose leakage throughout the experiment, Glucose leakage was evident in both the groups (Group 1, Group 2) with non-significant difference after 1 and 2 week and with significant difference after 3 week.

Conclusion: Newly introduced C Point have shown significantly lesser leakage as compared to the gold standard gutta-percha obturation system

INTRODUCTION

In recent years, the field of endodontics has taken major strides in various aspects, be it the operating microscope or a wide range of file systems and irrigation regimens. Despite these numerous developments, the materials and procedures for obturating root canal systems have not altered considerably. Since the introduction in 1867 by Bowman, Gutta Percha had been the standard obturation material utilized in root canal therapy. Even though Gutta Percha expresses many important properties, including chemical stability, biocompatibility, non-porosity, radiopacity and ability to be manipulated and removed but it does not chemically bond to internal tooth structures.1

To overcome these problems, the most recent advancement in endodontic obturating materials utilizes a hydrophilic polymer in the root canal. The system consists of prefabricated obturation points (CPoint) with an outer bonded hydrophilic polymer coating, a polyamide core and accompanying bioceramic sealer.2

These endodontic points absorb any remaining moisture from the instrumented root canal space and moisture that is already present in the dentinal tubules in order to expand laterally without expanding axially. It is stated that the lateral expansion of C Points occurs non uniformly, with the expandability depending on how much the hydrophilic polymer has been pre-stressed (i.e., contact with a canal wall will reduce the rate or extent of polymer expansion). Thus C Point as an obturating material thought to provide better seal because of its lateral hygroscopic expansion without causing significant damage to the dentinal microstructure (Somani R et al .2019).3

Endosequence BC sealer (Brasseler USA, Savannah, GA) is a premixed, injectable bioceramic endodontic sealer, and its nanoparticle size allowed it to flow into canal irregularities and dentinal tubules. It is hydrophilic and uses moisture in dentinal

tubules to initiate and complete its setting reaction. (2). BC sealer has the ability to form hydroxyapatite forming chemical bond with the dentin wall (3). It is composed of calcium silicates, calcium phosphate monobasic, calcium hydroxide and zirconium oxide

As it had already been demonstrated that adequate obturation of the root canal system following intracanal preparation is a major objective of endodontic treatment. Thus a great deal of attention has been given to the evaluation of sealing ability of root canal filling materials and associated obturation techniques.

Various test methods have been described to evaluate the quality of seal such as dye penetration, radioactive isotopes test, bacteria or bacterial metabolites leakage test, electrochemical technique and fluid filtration. However, the published reports often reach different or even conflicting conclusions. In 2005, an innovative method to evaluate seal ability was developed and referred to as the glucose leakage model (GLM) (Xu et al. 2005).4 In the GLM, glucose solution is used as a tracer and this methodology was accepted by an established research group as an improvement over the fluid transport method (Shemesh et al. 2006).5 The GLM represents an advance in methodology and has the potential to add value to the conclusions of laboratory leakage studies, particularly as glucose entering the root canal from the oral cavity could lead to multiplication of bacteria that might survive root canal preparation and filling and potentially lead to peri-apical inflammation (Xu et al. 2005).4 Therefore, the use of the GLM is thought to be more relevant than other tests (Xu et al. 2005, Shemesh et al. 2006).4,5 Thus the aim of the present study was to evaluate and compare the sealing ability of two single cone obturation systems using glucose leakage models at different time intervals.

MATERIALS AND METHODOLOGY

Thirty single-canaled lower premolar teeth with fully developed root apices were used in this study. Teeth were thoroughly cleaned for any soft tissue or calculus deposition using curettes, with care not to damage the root surface.

To ensure the same length for all specimens, the crowns of all teeth were removed using diamond disks keeping the length of all roots standardized at 12 mm. Apical patency was checked using #10 K-files. #15 K-file was inserted into each root canal for determination of the working length.

Instrumentation was done in a crown-down technique using rotary Protaper universal system (Dentsply Maillefer SA, Baillaigues, Switzerland). Rotary instrumentation was performed with the aid of electrical motor X-Smart device at speed of 250 RPM and torque of 3 N. The sequence of files used during instrumentation was that recommended by the manufacturer as SX, S1, S2, F1, F2 and F3 was used as final apical file. Shaping files were used in brushing motion while finishing files were used in straight in and out motion. Glyde file prep was placed on each file before insertion inside the canals. Smear layer removal was done using 2.5% NaOCl and 17% EDTA solution then the canals were finally flushed with 5 ml distilled water. Teeth were then divided into three equal groups, two experimental and one control group of ten teeth each.

In Group 1, ten roots were obturated with Protaper gutta percha with Endosequence bioceramic sealer. The tip of the sealer syringe was inserted into the canal no deeper than the coronal one third. Gently and smoothly a small amount (1-2 calibration markings) of the sealer was dispensed into the root canal by compressing the plunger of the syringe. Then the master gutta percha cone (size F3) was coated with the sealer and it was inserted in the canal with a pumping motion until it was fully seated. Obturation was done using Single-cone technique. In Group 2, ten roots were obturated by C Point and Endosequence bioceramic sealer. The sealer was inserted into the root canal as the previous group, the master C Point cone (size F3) was lightly coated with sealer then it was slowly inserted with a slight pumping motion to evenly distribute the sealer until it was fully seated. Obturation was done using Single-cone technique.

Rest of the ten roots were prepared but kept non-obturated to act as a control group.

Good quality radiographs had been taken to verify the quality of the root fillings. Then all specimens were stored at 37°C at 100% humidity for one week to simulate the oral conditions. Before testing the sealing ability of obturating materials, the external surfaces for groups 1 and 2 except the coronal access and the apical 2 mm, were covered with two layers of nail polish. For control group, root surfaces were completely covered with two layers of nail polish including the apex of the root and coronal access.

Microleakage along the root canal was evaluated using the glucose leakage model as described by Xu et al.4 The coronal part of each root was glued to the end of an Eppendorf vial using cyanoacrylate. Leakage at this connection was eliminated by the generous use of sticky wax. A hole was created in the cap of the Eppendorf vial, through which a plastic tube of at least 14 cm long was connected. A seal was obtained using cyanoacrylate glue and sticky wax. The assembly was then placed in a sterile 5 mL glass bottle with a screw cap and sealed with sticky wax (Fig 1). The tracer used in the present study was a 1 mol/L glucose solution (pH = 7.0), which density was 1.09 ×103 g/L and viscosity 1.18 × 10-3 Pas at 37°C. About 5 mL of the glucose solution, containing 0.2% NaN3, was injected into the Eppendorf vial from the plastic tube until the top of the solution was 14 cm higher than the top of obturating material in the canal, which created a hydrostatic pressure of 1.5 kPa (15 cm H2O). The glass bottle contained 1 mL 0.2% solution of NaN3, in which glucose that passed through the obturated canal would be collected. The NaN3 was used here to inhibit the proliferation of microorganisms that might decompose glucose. The seal at all junctions of the system was checked by connecting the open end of the plastic tube to compressed air. Any bubbles would indicate leakage of the assembly. The model was then transferred to an incubator that provided 100% humidity and 37°C temperature for the duration of observation periods.

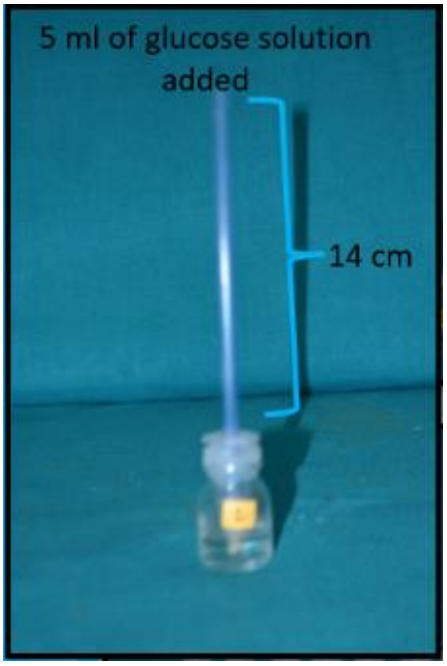

Fig 1: Glucose leakage model

Measurement of microleakage :A 10 µl aliquot of solution was drawn from the glass bottle using a micropipette at 1 day ,1 week, 2 week and 3rd week(Fig:2). After drawing the sample, 10µl of fresh 0.2% NaN3 was added to the glass bottle reservoir to maintain a constant volume of 1 ml. The concentrations of leaked glucose (mg/dL) were measured after 1 day and then after 1, 2 and 3weeks with a Glucose kit (Glucose Liquid, Quimica ClinicaApplicada S.A) in a spectrophotometer (Beckman Du 520, Coulter, Germany) at a wavelength of 500 nm.

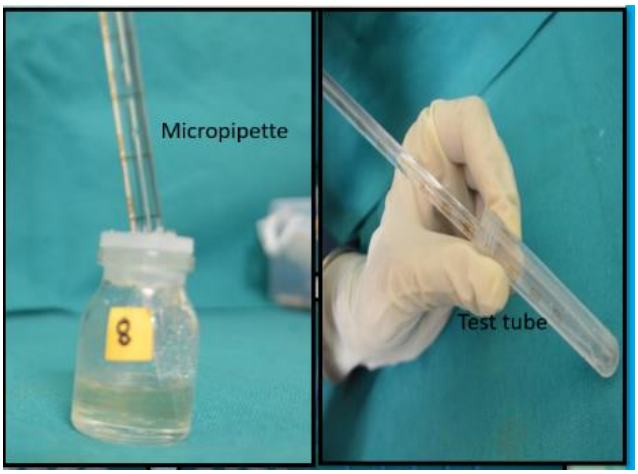

Fig:2: 10ul of test solution withdrawn from apical reservoir

RESULTS

The data was subjected to statistical analysis using SPSS version 19. The $p< 0.05$ is considered statistically significant and Mann-Whitney test was used to compare the glucose leakage among various groups.

The control group showed no detectable glucose leakage throughout the experiment, this indicates that the seal of the glucose leakage model was effective and reliable.

Descriptive and comparative statistical results of glucose leakage obtained from the experimental groups are summarized in Table 1.

In Group 1 (Gutta percha) and Group 2 (C Point) no glucose leakage was detected only after first 24 hours. Thereafter glucose leakage was evident in both the groups with non-significant difference after 1 and 2 week and with significant difference after 3 week.

In table 2 values showed that the rate of glucose leakage in gutta percha group increases gradually and significantly with time whereas C point recorded inconsistent glucose leakage and showed less glucose leakage at the end of experimental period.

TABLE 1: Mean Glucose leakage in mg/dl during the experimental period

Time Intervals	N	Group 1 (Mean±SD)	Group 2 (Mean±SD)	P value	Significance
1 week	10	0.90±0.73	0.40±0.51	0.112	Non-Significant
2 week	10	1.50±1.08	0.90±0.73	0.190	Non-Significant
3 week	10	2.80±1.39	1.20±0.91	0.006	Significant

Mann Whitney U test with level of significance at $p\leq0.05$

TABLE 2: Percentage increase in glucose leakage during experimental period

Time Intervals	**GROUP 1 (GUTTA PERCHA)**	**GROUP 2 (C POINT)**
1 WEEK TO 2 WEEK	66.67%	55.56%
2 WEEK TO 3 WEEK	86.67 %	33.33%

DISCUSSION

Success in root canal treatment is founded upon the triad of thorough canal debridement, effective disinfection and obturation of the canal space. Historically, a significant share of this triad has been allocated to obturation of the canal space.6 Thus to know sealing ability of two different obturating materials, the present study had been undertaken.

Mandibular premolars with single canals were selected for this study as they have oval shaped canals, providing space between the rounded gutta percha and the root canal walls, such space will need greater amount of sealer between the filling material and root canal walls, which requires the use of a sealer with optimum sealing ability.7

For standardization, the teeth were decoronated and the length of all the roots were fixed to 12mm as it was found by Metzeger et al and Mozini et al that the length of filling material would affect the rate of glucose leakage.8,9 Also the volume of the canals were standardized to the same taper and size by the use of universal protaper rotary files up to file size F3 using crown down technique.

Various methods have been developed to assess sealing ability of root canal filling materials, usually based on the same principle, that is to evaluate the penetration of a tracer along the obturated canal of an extracted tooth. Several tracers such as dye, radioisotope, bacteria and their products had been used for evaluation of microleakage.

The dye penetration is the most popular , probably because it is simple and inexpensive method. However this method often yielded a large variation of the result and could hardly be reproducible and comparable.

Assessment of bacterial leakage might be more biologically relevant than that of dye or radioisotope penetration but the conclusions might vary with bacterial species used. Maintaining aseptic condition throughout all steps of the experiment can be difficult.

Radioisotope labelling and electrochemical methods technique were less frequently employed because they pose a radiation hazard and require sophisticated materials and apparatus.

The fluid filtration method which was developed by Derkson et al 10 for measuring dentin permeability and later modified by Wu et al11 to evaluate endodontic leakage, is gaining popularity because it is sensitive and non destructive and permits repeated observation of the same specimen over time. However there was no standardization of the methods, such as measurement time, the applied pressure ,the diameter of the tube containing the bubble, length of the bubble which might influence the results.

Thus the choice of tracer should be carefully chosen because its size and physiochemical properties may influence the result. That is why in the present study, glucose was chosen as the tracer because of its small molecular size i.e (MW=180 Da) and it is a nutrient for bacteria. If glucose could enter the canal from the oral cavity, bacteria that might survive root canal preparation and obturation could multiply and potentially lead to periapical inflammation.12 Glucose therefore was thought to be more clinically relevant than other tracers used in microleakage tests.

Quantitative analysis of leakage was possible by determining the concentration of glucose in the apical reservoir that leaked through the filled root canal. To determine the concentration of glucose, the enzymatic glucose oxidase method was chosen

because it provided the ultimate degree of specificity and high sensitivity when compared with other methods such as copper or ferricyanide methods.

With this method glucose is oxidized by the enzyme glucose oxidase in the presence of oxygen to gluconic acid with formation of hydrogen peroxide. Then in the presence of peroxidase enzyme, a chromogenic oxygen acceptor (4-amino antipyrine and phenol) is oxidized by H2O2 resulting in the formation of a red product (oxidized chromogen).

The quantity of this oxidized chromogen is proportional to the glucose present initially in the first reaction ,which quantity is determined by spectrophotometry.

The results of this study indicate that both obturation systems allow variable degrees of glucose leakage. The glucose leakage values of Gutta percha used along with endosequence bioceramic were significantly higher at the end of the experimental period. This might be explained by the lack of bonding between this sealer and gutta-percha due to its hydrophobic property .Least leakage is seen in Group 2 (C point+ Endoseuence bioceramic sealer). C-point contain a polyamide core with an outer bonded hydrophilic polymer coating , that is being recommended to use along with bioceramic sealer. The endodontic points are designed to expand laterally without expanding axially by absorbing residual water from the instrumented root canal space and the naturally present moisture in the dentinal tubules. The inner core of is a C-points mix of two proprietary nylon polymers: Trogamid T and Trogamid CX. The polymer coating is a cross-linked copolymer of acrylonitrile and vinylpyrrolidone which has been polymerized and cross-linked using allyl methacrylate and a thermal initiator. The lateral expansion of C points is claimed to occur nonuniformly with the expand-ability depending on the extent to which the hydrophilic polymer is prestressed (i.e., contact with a canal wall will reduce the rate or extent of polymer expansion). Moreover due to its hydrophilic nature ,C Point bonds chemically with biocermanic sealer. This was might be the reason for less glucose leakage in teeth obturated with C point and bioceramic sealer.

CONCLUSION

Newly introduced C Point have shown significantly lesser leakage as compared to the gold standard gutta-percha obturation system. Furthermore, studies would be required to authenticate the results

REFERENCES

1. Hegde V, Arora S. Sealing ability of a novel hydrophilic vs conventional hydrophobic obturation systems: a bacterial leakage study. J Conserv Dent 2015;18(1):62–65. DOI: 10.4103/0972-0707.148898.
2. Hegde V, Arora S. Fracture resistance of roots obturated with novel hydrophilic obturation systems. J Conserv Dent 2015;18(3):261–264. DOI: 10.4103/0972-0707.154047.
3. Somani R, Jaidka S, Singh DJ, Kaur N. Hermetic Seal in Obturation: An Achievable Goal with Recently Introduced Cpoint. Int J Clin Pediatr Dent. 2019 Sep-Oct;12(5):410-413. doi: 10.5005/jp-journals-10005-1619. PMID: 32440046; PMCID: PMC7229356.
4. Xu Q, Fan MW, Fan B, Cheung GS, Hu HL. A new quantitative method using glucose for analysis of endodontic leakage. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2005;99:107–11
5. Shemesh H, Wu M-K, Wesselink PR (2006) Leakage along apical root fillings with and without smear layer using two different leakage models: a two month longitudinal ex vivo study. International Endodontic Journal 39, 968–76.
6. Li G, Niu L, Zhang W, Olsen M, De-Deus G, Eid AA, Chen J, Pashley DH, Tay FR. Ability of new obturation materials to improve the seal of the root canal system-A Review. Acta Biomater 2014;10(3): 1050–1063.
7. Wu MK, Kast'áková A, Wesselink PR. Quality of cold and warm gutta-percha fillings in oval canals in mandibular premolars. Int Endod J. 2001 Sep;34(6):485-91. doi: 10.1046/j.1365-2591.2001.00463.x. PMID: 11556517.
8. Metzger Z, Abramovitz R, Abramovitz L, Tagger M. Correlation between remaining length of root canal fillings after immediate post space preparation and coronal leakage. J Endod. 2000;12:724-8
9. Mozini A, Vansan P, Neto M, Pietro R. influence of the length of remaining root canal filling and post space preparation on the coronal leakage of Enterococcus Faecalis. Braz J Microbial. 2009;40:174-9.
10. Derkson GD, Pashley DH, Derkson ME. Microleakage measurement of selected restorative materials: a new in vitro method. J Prosthet Dent. 1986; 56: 435-40.
11. Wu M.-K,Wesselink P.R. Endodontic leakage studies reconsidered. Part 1: Methodology, application and relevance. Int Endod J. 1993; 26: 37-43
12. Hegde V, Arora S. Sealing ability of three hydrophilic single-cone obturation systems: An in vitro glucose leakage study. Contemp Clin Dent. 2015 Mar;6(Suppl 1):S86-9. doi: 10.4103/0976-237X.152953. PMID: 25821383; PMCID: PMC4374327.