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ARTICLE

SEALING ABILITY OF CPOINT -SMART PASTE BIO VERSUS GUTTA PERCHA- AH PLUS USING GLUCOSE LEAKAGE MODEL: AN IN-VITRO STUDY

Sarika Chandra, Sylvia Mathew*, B.V.Sreenivasa Murthy, Poornima Ramesh, John V. George, Swaroop Hegde

Dept. of Conservative Dentistry and Endodontics,Faculty of Dental Sciences, Ramaiah University of Applied Sciences,Bengaluru, INDIA

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ABSTRACT

Background: *To compare the sealing efficacy of CPoint- SmartPaste Bio system and Gutta percha –AH plus using a Glucose Leakage Model.* ***Method:*** *50 extracted human mandibular premolar teeth were decoronated and chemo-mechanical preparation performed for all the samples. They were divided into Group I and II (n=20) and control groups Group III and IV (n=5). Samples in Group I were obturated using CPoint and SmartPaste Bio and Group II with Gutta percha and AH plus sealer. Group III, positive control were obturated with Gutta percha without any sealer. Group IV, negative control samples were coated with nail varnish completely. The prepared samples were subjected to microleakage testing using the Glucose Leakage Model. Aliquots of 10 µL were drawn using micropipettes on day 1 and Week 1,2,3,4,5,6,7, 8 and subjected to Glucose oxidase –Peroxidase testing. The optical density reading was obtained using a dual- wave spectrophotometer at 505 nm. Data was analysed using SPSS (Statistical Package for Social Science, Ver.10.0.5).* ***Results:*** *Leakage was observed in all groups except for Group IV. Leakage in Group II and Group I, significantly increased from the 4th week. The mean values at the end of 8 weeks was greater for the samples of Group I, CPoint- SmartPaste Bio as compared to Group II, Gutta percha – AH plus though not statistically significant.* ***Conclusions:*** *The microleakage observed with CPoint- SmartPaste Bio (Group I) was similar to that of Gutta percha-AH plus (Group II) thus suggesting similar sealing ability of both obturating materials.*

KEY WORDS
CPoint – SmartPaste Bio; Glucose Leakage Model; Gutta percha –AH plu

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***Corresponding Author**
Email: sylviamathew@gmail.com
Tel: +91-080-23602079

INTRODUCTION

Root canal filling materials must seal the canal three dimensionally to prevent ingress of microorganisms or toxins into the canal space; that is to achieve a “fluid tight seal”[1,2]. Innumerable materials have been formulated to enable effective and complete sealing of the root canal system. Wu and Wesselink have concluded that due to the discrepancy in results, it is difficult to draw conclusions as to which filling material or technique is the best to seal the root canal system [3].

In the past decade, a wide variety of rotary Ni-Ti instruments have been developed and marketed to facilitate the tedious and challenging process of cleaning and shaping of the root canals. Single gutta percha cones matching the geometry of these Ni-Ti files have also been fabricated for ease of obturation of the prepared canals. Single cone obturation points and sealers result in a uniform mass thus eliminating the need of accessory cones [4].

Obturating materials do not have fixed, inert and impenetrable borders but have dynamic micro crevices, which contain busy traffic of bacteria, ions, and molecules [5]. Microleakage (apical or coronal) is a major factor determining the clinical and biological outcome of root canal treatment. Therefore in-vitro assessment of microleakage of any novel obturating material is important before incorporating it into clinical practice.

Endo Technologies, LLC, USA has launched a novel point and paste root canal filling technique called the C Point system. C stands for the Latin word “cresco” (cretum), which means to grow, expand or increase. As the name suggests, CPoints are designed to expand laterally without expanding axially by absorbing residual water from the instrumented canal space [6]. It is used with an accompanying resin based bioceramic sealer, marketed as SmartPaste Bio.

The different techniques devised for the evaluation of microleakage include: assessment of linear and volumetric dye penetration, autoradiographic detection of isotope penetration, radionuclide detection, culture techniques to detect bacterial penetration, salivary penetration models, fluid filtration techniques, fluorometry, intra-canal reservoir techniques, electrochemical techniques etc. 3 In 2007, the Editorial Board of the Journal of Endodontics declared that ‘sealability studies comparing endodontic procedures using the penetration of dyes, chemicals etc. are not useful to endodontic science and the Editorial Board has agreed to restrict publication of sealability studies using these techniques’. 3 Trying to overcome the drawbacks of the other microleakage techniques Xu et al. developed the Glucose Leakage Model in 2005 which uses glucose as a tracer molecule [7,8].

The knowledge of the sealing efficacy of any obturation material is incredibly essential as it is one of the principal factors governing the clinical outcome of endodontic treatment. Therefore, the aim of this study was to assess and evaluate the sealing efficacy of CPoint-SmartPaste Bio against the most prevalently used method, gutta percha in combination with AH plus sealer.

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MATERIALS AND METHODS

Fifty human mandibular premolar teeth extracted for orthodontic purpose was selected for the study. All teeth were decoronated using a safe- sided diamond disc and root lengths were standardized to 15mm. Access was gained using a #2 endodontic access diamond bur (Dentsply Maillefer, Ballaigues, USA) and patency was established using a #10 K file (Mani Inc., Japan). Chemo-mechanical preparation was done till #30/0.06 using the RaCe rotary Ni-Ti system (FKG Dentaire, Suisse, Switzerland) with copious irrigation using 3% Sodium hypochlorite. After completion of the chemo-mechanical preparation, irrigation was done with an additional 3 ml of 3% sodium hypochlorite. This was followed by irrigation with distilled water and then 1ml of 17% EDTA to remove the smear layer. Final irrigation was done with distilled water. The teeth were then randomly divided into 2 experimental groups (n=20 each) and 2 control groups (n=5 each).

The samples in the 1st experimental group; Group I (n= 20) were obturated using CPoint and SmartPaste- Bio sealer (EndoTechnologies, LLC, Shrewsbury, MA,USA) as per the manufacturers' instructions. The samples in Group II (n= 20) were obturated using gutta percha points with AH plus sealer (Dentsply Maillefer, Ballaigues, USA) using lateral condensation technique. The positive control group (Group III) consisted of teeth obturated with gutta percha without the use of any sealer. The teeth in the negative control group (Group IV) did not receive any treatment and were sealed externally with two coats of nail varnish.

The teeth were subsequently mounted in the Glucose leakage model, as proposed by Xu et al for evaluation of microleakage [7]. 10 µL of sample from the lower chamber of the glucose leakage model was withdrawn with the help of a micropipette on day 1 and weeks 1,2,3,4,5,6,7 and 8. The lower chamber was replenished with 10 µL of 0.2% sodium azide each time a sample was withdrawn for evaluation. The sample withdrawn was subjected to Glucose- oxidase and peroxidase (GOD-POD) testing. The optical density of the solution obtained after subjecting the sample to GOD-POD testing was evaluated using a spectrophotometer (Elico double beam UV visible spectrophotometer SL 164, India) set at 505 nm.

RESULTS

Leakage was observed in both the experimental groups, which was time dependant. There was a substantial increase in leakage from the fourth week onwards in both the experimental groups with CPoint – SmartPaste Bio exhibiting more leakage than teeth obturated with gutta percha – AH plus [Fig. 1].

TABLE 1: Inter- group comparison in the micro leakage values obtained using a Spectrophotometer

Pair wise comparison (p value)			
Visit	Group I vs II	Group I vs III	Group II vs III
Day 1	0.984	<0.001	<0.001
Week 1	0.974	<0.001	<0.001
Week 2	1.000	<0.001	<0.001
Week 3	0.999	<0.001	<0.001
Week 4	0.793	<0.001	<0.001
Week 5	0.291	<0.001	<0.001
Week 6	0.321	<0.001	<0.001
Week 7	0.304	<0.001	<0.001

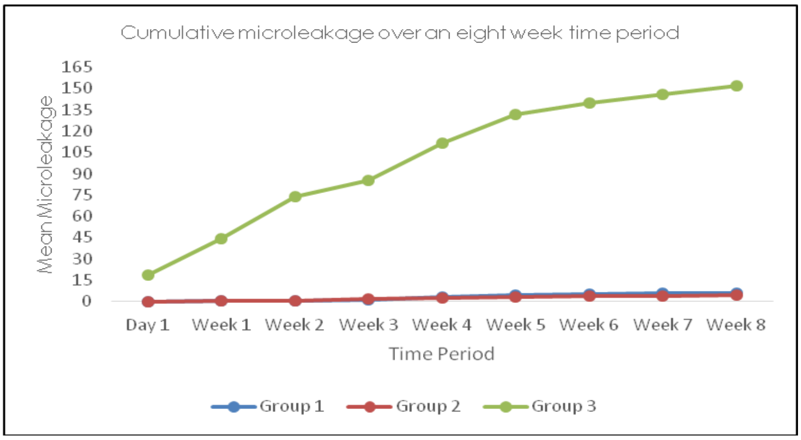

Fig.1: Cumulative micro leakage of Groups I, II and III over an eight week time period.
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DISCUSSION

The ultimate goal of root canal treatment is to prevent reinfection of the root canal through an impermeable fluid tight seal achieved by means of a three dimensional obturation of the root canal system. C-Point is a novel obturating material that is said to exhibit non- isotropic lateral expansion to enhance the sealing ability of the material. This study was hence undertaken to evaluate the sealing ability of CPoint; in conjunction with Smart Paste Bio using the Glucose Leakage Model.

At the end of the test period it was observed that Groups I, II and III exhibited significant leakage, establishing a positive correlation between leakage and time. The mean leakage values in Groups I and II were found to be similar from day 1 to week 3. At the 4th week, the leakage values for both these groups were found to be significantly more as compared to their baseline values. At the end of the test period, the mean leakage value for Group I was 6.624 $\pm$ 1.771 and for Group II 4.449 $\pm$ 1.777, showing significant glucose leakage in both groups [Table 1]. The mean leakage value was found to be greater for Group I as compared to Group II at the end of 8 weeks, but this difference was not statistically significant. The performance of CPoint- SmartPaste Bio seemed to deteriorate with increasing time.

The lateral expansion of CPoint is claimed to occur non-uniformly, with the expandability depending on the extent to which the hydrophilic polymer is pre-stressed (i.e. contact with a canal wall will reduce the rate or extent of polymer expansion) [9]. As claimed by the manufacturer, gaps may still remain between the walls of the canal and the expanded point. Consequently, an accompanying sealer must be used to seal those areas. Therefore the accompanying sealer used is a resin-based sealant with the addition of bioceramic marketed as SmartPaste Bio. SmartPaste bio produces calcium hydroxide and hydroxyapatite as by- products of the setting reaction, rendering the material both anti-bacterial while setting and biocompatible once set. It has a delayed setting time of 4-10 hours enabling expansion of the CPoint thereby facilitating filling of any voids, as put forth by the manufacturers. The results of our study contradict the claims about the superior sealing ability of CPoint [6].

The proposed explanation for the greater leakage of CPoint/SmartPaste Bio in our study is based on the interaction of water with hydrophilic copolymers such as CPoint. CPoint is composed of an inner core of Nylon with a polymeric coating. The inner core of CPoint is a 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 polymerised and cross-linked using allyl methacrylate and a thermal initiator. CPoint expands when in contact with water due to the affinity of the polymeric coating for water. Vinylpyrrolidone [10] and Acrylonitrile [11] have polar functional groups. Hydrophilic polymers owing to their polar functional groups are able to absorb and adsorb large volumes of water, which can affect their functionalities [12]. The interaction of water lowers the glass transition temperature due to its universal plasticizing activity. During the study it was noticed that prior to contact with water, CPoint was rigid in nature. However, after contact with water it turned into a more rubbery consistency. This is consistent with the aforementioned statement about the effect in glass transition temperature on contact with water.

The underlying molecular mechanism proposed is the binding of water molecules to the polar groups of the materials, that weaken the attraction forces between the polymer chains, consequently increasing the free volume. Water molecules may penetrate into the hydrophilic polymer matrix, increasing the distance between the polymer chains thus providing more free volume for molecular movements [13]. At higher moisture levels water molecules weaken the hydrogen bonds between polymer chains and lead to the plasticization of the material and increased free volume [14]. This can lead to the presence of microscopic voids [15] within the polymeric matrix, which in turn could provide a pathway for leakage of the glucose tracer molecule. Similar to other copolymers, water absorption by vinylpyrrolidone–acrylonitrile copolymer affects the biocompatibility of the material [16], as leaching of water-solubilised materials may occur [17]. However, Eid et al evaluated the biocompatibility of CPoint and concluded that the in vitro biocompatibility is comparable to gutta-percha with minimal adverse effects on osteogenesis after elution of potentially toxic components [18].

In the present study, glucose was selected as the tracer molecule because it has a small molecular size (MW = 180 Da) and is also a nutrient for bacteria. If glucose can enter the canal from the oral cavity, bacteria that may survive root canal treatment could multiply and potentially lead to periapical inflammation. To determine the concentration of glucose, the enzymatic glucose oxidase- peroxidase method (GOD-POD method) was chosen because it provides a higher degree of specificity and sensitivity when compared to other methods, such as copper or ferricyanide methods [19]. In 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 a peroxidase enzyme, a chromogenic oxygen acceptor (4-aminoantipyrine and phenol) is oxidized by the hydrogen peroxide, resulting in the formation of a red product, which is an oxidized chromogen [7]. The quantity of this oxidized chromogen is proportional to the glucose present initially in the first reaction, the quantity of which is determined using a dual- wave spectrophotometer. This model enables us to quantify the endodontic microleakage cumulatively over time. In addition, the coronal low pressure could help rule out entrapped air or fluid and seemed to be sufficient for a device with high sensitivity [20].

As the Glucose Leakage Model is manually assembled, there could be some variations in readings within every group, accorded to human error. Additonally, the obturating materials may potentially react with glucose as demonstrated in a study by Shemesh et al.[8] Further research on the structure, biocompatibility and sealing ability of CPoint needs to be undertaken.

CONCLUSION

Within the limitations of this study, it was observed that both the experimental groups exhibited leakage as recorded using Glucose leakage model and this leakage was time dependant.

CONFLICT OF INTEREST

Authors deny any conflict of interest related to the study

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REFERENCES

[1] Ingle J, Bakland LK, Baumgartner JC. Ingle's Endodontics. 6th Edition. CBS Publishers.
[2] Cobankara FK, Adanir N,[2004] Belli S. Evaluation of the Influence of Smear Layer on the Apical and Coronal Sealing Ability of Two Sealers. J Endod. 30: 406-409.
[3] The Editorial Board of the Journal of Endodontics. [2007] Wanted: A base of evidence. J Endod 33(12): 1401-1402.
[4] Wilson BL, Baumgartner JC.[2003] Comparison of spreader penetration during lateral compaction of .04 and .02 tapered gutta percha. J Endod. 29: 828-831.
[5] Muliyar S, Shameem KA, Thankachan RP, Francis PG, Jayapalan CS, Hafiz KAA. [2014] Microleakage in Endodontics. J Int Oral Health. 6(6):99-104.
[6] Didato A, Eid AA, Levin MD, Khan S, Tay FR, Rueggebery FA. [2013] Time-based lateral hygroscopic expansion of a water-expandable endodontic obturation point. J Dent. 39(7): 883-888.
[7] Xu Q, Fan MW, Fan B. Cheung GS, Hu HL.[2005] A new quantitative method using glucose for analysis of endodontic leakage. Oral Surg Oral Med Oral Pathol Oral Radiol and Endod. 99: 107-111.
[8] 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. Int Endod J. 39: 968-976.
[9] Highgate DJ, Lloyd JA. [2007] Expandable/contractable composition for surgical or dental use. United States Patent number7, 210:935,
[10] Patent EP 0660863 A1. Fluoroalkyl siloxane/vinyl copolymer dispersions and pressure-sensitive adhesives having improved solvent resistance prepared therefrom.
[11] Tsarevsky NV, Bernaerts KV, Dufour B, Du Prez FE, Matyjaszewski K. [2004] Macromolecules. 37: 9308-9313.
[12] Thibert R, Hancock BC.[1996] Direct visualization of superdisintegrant hydration using environmental scanning electron microscopy, J Pharm Sci. 85: 1255-1258.
[13] Abiad MG, Carvajal MT, Campanella OH.[2009] A review on methods and theories to describe the glass transition phenomenon: Application in food and pharmaceutical products., Food Eng Rev. 1: 105-132.
[14] Dlubek G, Redmann F, Krause-Rehberg R. [2002] Humidity –induced plasticization and antiplasticization of polyamide6: A positron lifetime study of the local free volume, J Appl Polym Sci. 84: 244-255.
[15] Szakonyi G, Zelkó R.[2012] The effect of water on the solid state characteristics of pharmaceutical excipients: Molecular mechanisms, measurement techniques, and quality aspects of final dosage form. Int J Pharm Investig. 2(1): 18-25.
[16] Wan LS, Xu ZK, Huang XJ, Huang XD, Yao K. [2007] Cytocompatibility of poly(acrylonitrile-co-N-vinyl-2-pyrrolidone membranes with human endothelial cells andmacrophages, Acta Biomaterialia. 3: 183–190.
[17] Donnelly A, Sword J, Nishitani Y, et al. [2007] Water sorption and solubility of methacrylate resin-based root canal sealers, J Endod. 33: 990–994.
[18] Eid AA, Nikonov Y, Looney SW. [2013] In vitro biocompatibility evaluation of a root canal filling material that expands on water sorption, J Endod. 39 (7): 883-888.
[19] Bishop ML, Duben-Engelkirk JL, Fody EP.[1985] Clinical chemistry principles, procedures, correlations. 2nd ed. Philadelphia: Lippincott; p. 307-309.
[20] Pommel L, Camps J. [2001] Effects of pressure and measurement time on the fluid filtration method in endodontics. J Endod. 27: 256-258.