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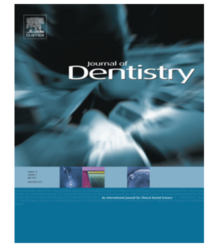

Time-based lateral hygroscopic expansion of a water-expandable endodontic obturation point

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ABSTRACT

Objectives: This study compared the time-based lateral expansion of two sizes and two batches of water-expandable obturation points (CPoint, EndoTechnologies, LLC) and a similar-sized gutta-percha point (control) at various distances from the point apex: 5, 10, and 15 mm.

Methods: Two batches of sizes 25 and 40 (0.06 taper) CPoints and a single lot of size 40 (0.06 taper) gutta-percha were tested (N = 5). Points were fixed to the bottom of a Petri dish, and digital images of each point location were obtained under 50× magnification, which also captured a calibrated linear scale reticule. After imaging each dry cone location, 10 mL of water was added, and images were obtained at various time points: 20 and 40 min, 1, 2, 3, 4, 5, 6, 7, 8, and 24 h. Between measurements, dishes were stored at 37 °C. Side-to-side dimension of each point was determined using imaging software

Results: No significant differences ($p > 0.05$) in lateral dimension at each tip distance between batches of similar-sized CPoint samples were found (2-tailed unpaired Student's *t*-test). Changes in CPoint dimension were significantly higher ($p < 0.05$) for both sizes at each tip distance after 20 min of water immersion (one-factor repeated-measures ANOVA; Tukey test). Gutta-percha did not significantly change from the dry value during water immersion ($p > 0.05$).

Conclusions: When exposed to water, the lateral expansion of a new hydrophilic endodontic obturation point significantly increases in dimension within 20 min, whereas a conventional gutta-percha point does not.

1. Introduction

Obturation of root canals should prevent re-infection of the canal space and ultimately prevent periradicular disease.[1] This objective may be achieved by three-dimensional filling of the instrumented canal, accessory canals, and dead spaces.[2] While different canal filling techniques are currently available to achieve this goal, there is on-going interest in developing

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simplified obturating materials/techniques for filling irregular-shaped canals, and to minimise voids created during obturation procedures, which may act as niduses for growth of residual biofilms.

The CPoint system (EndoTechnologies, LLC, Shrewsbury, MA, USA) is a point-and-paste root canal filling technique that consists of pre-made, hydrophilic endodontic points and an accompanying sealer. The deformable endodontic point (CPoint) is available in different tip sizes and tapers and is designed to expand laterally without expanding axially, by absorbing residual water from the instrumented canal space and that from naturally-occurring intraradicular moisture.[3] 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. 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).[4] This non-isotropic lateral expansion is said to enhance the sealing ability of the root canal filling, thereby reducing the possibility of re-infection, and potentiating the long-term success of root canal treatment. As claimed by the manufacturer, although CPoint is capable of achieving a relative good fit of an irregular canal space, gaps may still remain between the walls of the canal and the expanded point. Consequently, an accompanying sealer must to be used to seal those areas.

To date, there has been no direct comparison of the lateral expansion capability of CPoint with that of gutta-percha, the most widely used root filling material, in the presence of a water-containing environment. In addition, the batch-to-batch variation in lateral expansion of CPoint among different sized points remains untested. Thus, the objective of the present study was to examine the effect of water storage time at simulated physiologic temperature on the extent of lateral expansion of CPoint at various distances from the point apex, and the batch-to-batch variation. The null hypothesis tested was that there is no significant difference in lateral expansion between CPoint and gutta-percha points.

2. Materials and methods

The endodontic points tested included two batches and two sizes of CPoint: 25 (Lot #P010312a-2Z and #P180612a-3Z), and 40 (Lot #P180512a-3Z and #P180612a-3Z), both 0.06 taper. One batch of size 40, 0.06 taper gutta-percha points (EndoSequence, Brasseler USA, Savannah, GA, USA) was used as the control.

2.1. *Specimen preparation*

Individual points were secured to the bottom surface of a Petri dish using sticky wax, so that the wax droplets did not interfere with water sorption at the sites of measurement. The coronal end of each endodontic point was also sealed with wax to prevent water infiltration through that end. Each point was marked with indelible pen at three locations (5, 10, and 15 mm) from the apical end.

2.2. *Specimen dimension measurement*

Imaging was accomplished under 50× magnification using a binocular microscope (Model STM, Olympus, Tokyo, Japan). The eyepiece reticule of the microscope was calibrated using a graduated scale capable of providing 10-μm divisions. This method provided accurate measurements from digitally-recorded images within a narrow field of focus. Prior to water sorption, a digital image of each secured point was captured at each of the three locations. The width dimensions for these images were considered as the baseline "non-water-exposed" values.

Ten millilitres of 35 °C deionised water was then added to each Petri dish. Images at each of the three locations of an endodontic point were obtained at 20 and 40 min, 1, 2, 3, 4, 5, 6, 7, 8, and 24 h. Immediately after each measurement, the specimen dish was covered and placed inside a 37 °C incubator to prevent water evaporation. When a measurement was to be taken, the dish was retrieved from the oven, and placed on a temperature-controlled stage under the microscope (Fig. 1A).

2.3. *Calibration of image dimensions*

The digital image of a calibrated, ruled reticule (100 × 0.01–1 mm, Graticules Ltd., Tonbridge, Kent, UK), providing lined increments at 10 μm spacing, was imported into an imaging processing software (Image J, NIH, Bethesda, MD, USA). Using linear scaling plug-ins, the pixel length of the 1-mm long reticule was determined and applied to the linear measurements of subsequent images.

2.4. *Determination of lateral expansion*

Once this linear scaling factor was determined, the diameters (in mm) of each point at the 3 designated tip distances were determined, using landmarks made on the side of the point (Fig. 1B). Images of the same point were obtained for the aforementioned 11 periods of water immersion, from which the shaft diameter of each point over the duration of water storage was determined.

2.5. *Specimen randomisation*

The order of specimen imaging was randomised with respect to type of point, batch, and replication number. However, when an individual point was measured, three individual images (one at each of the three locations) were obtained in sequence. Thus, five test groups were established, with five obturation points randomly assigned to each group to fulfil the testing of all specimens.

2.6. *Statistical analyses*

The study design and statistical analyses took into consideration statistical pitfalls common in oral and dental research.[5] For comparison of expansion difference between CPoint batches, the shaft diameter of two size-25 batches ($N = 5$) were compared separately at baseline (pre-immersion), and after 24 h of water immersion, for each of the three designated tip distances, using 2-tailed, unpaired Student's *t*-tests. Similar analyses were performed for the two size-40 batches ($N = 5$).