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Original Article

Thermoplasticity of microseal and TC gutta-percha (Tanaka de Castro) and three gutta-percha cones

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Abstract

Aim: The aim of this study was to assess the thermoplasticity of materials used in root canal filling. **Methods**: Specimens with standardized dimensions were fabricated using Tanari, Roeko and Activ Point gutta-percha cones, as well as Microseal and TC gutta-percha. After 24 hours, the specimens were placed in water at 70 ºC for 60 seconds and positioned between two glass slabs. Each set was compressed by a 5 kg weight. Digital images of the specimens before and after compression were obtained and analyzed. The thermoplasticity was evaluated based on the difference between the final and initial areas. Data were statistically analyzed using ANOVA and Tukey's tests at a 5% significance level. **Results**: TC and Microseal gutta-percha presented the highest thermoplasticity ($p < 0.05$). Among the gutta-percha cones, Tanari and Roeko presented the highest thermoplasticity and differed when compared to Activ Point ($p < 0.05$). **Conclusions**: The results of the present study showed that TC and Microseal gutta-percha filling systems present better thermoplastic properties.

Keywords: endodontics, root canal filling materials, gutta-percha.

Introduction

The main objective of endodontic treatment, after the cleaning and shaping of the root canals, is the complete filling of the pulp cavity in three dimensions[1,2]. Two factors are important in the three-dimensional filling of the root canal system, namely, the filling technique[1] and the properties of the material employed[3].

Since root canal sealers may dissolve over time and shrink during setting[4], it has been suggested that the ideal root canal filling should consist of a sufficient amount of gutta-percha covered by a thin layer of sealer[4-6]. As a result, several filling techniques employing thermoplastic gutta-percha have been evaluated with regard to their effectiveness in filling irregular or lateral canals[5-11].

Gutta-percha is available in two different crystalline forms and may be converted from one form into another. When extracted, gutta-percha is in its natural, alpha form; beta is the processed form, ready for use in endodontics[12]. However, some current filling techniques also employ gutta-percha in the alpha form, which is characterized by a lower melting point, lower viscosity and higher flow when compared to the beta form[13].

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The clinical advantages associated with the alpha form of gutta-percha resulted in the development of the Microseal system (Sybron Endo, Orange, CA, USA). In Brazil, a similar process of thermoplastic root canal filling, the TC system (Tanaka de Castro & Minatel Ltda., Cascavel, PR, Brazil) was developed and patented in 2002, aiming at making this technique more accessible to the clinicians while preserving the main properties of the Microseal system.

In thermoplastic or thermomechanical root canal filling methods, assessing the properties of gutta-percha when submitted to heat is of paramount importance[12,14-17]. The thermoplasticity of gutta-percha cones is affected by their chemical composition[14,16-19], as well as by thermal changes resulting from the manufacturing process and use of these materials[16,18]. Although several endodontic techniques have been evaluated with respect to their ability to adequately fill the root canal and its irregularities[5-11], few studies have focused on the thermoplasticity of different brands of gutta-percha cones used in thermomechanical methods[3,20,21,22].

The aim of the present study was to assess the thermoplastic properties of gutta-percha from Microseal and TC System, and three gutta-percha cones, namely Tanari, Roeko, and Activ GP.

Material and methods

Five specimens (1.5 mm thick, 10 mm in diameter) were fabricated from each of the brands of gutta-percha listed in **Table 1**, i.e. three different brands of gutta-percha cones as well as Microseal and TC gutta-percha.

Material samples were kept in water at 70 ºC for 60 seconds, using a thermometer-controlled heating apparatus (Righetto e Cia., Campinas, SP, Brazil). The heated materials were placed into standardized rings with the above-mentioned dimensions (1.5 mm thick, 10 mm in diameter) and pressed between two glass slabs under controlled and constant force (0.5 N) for one minute. Thereafter, the specimens were removed from the molds, the excess material was trimmed and dimensions were checked using a digital caliper. Specimens were kept at a temperature between 25 and 30 ºC for 24 hours and then returned to the heating apparatus at 70 ºC for 60 seconds. Next, each sample was again positioned between two glass slabs and a 5 kg weight was placed on the top of the slabs to produce a compressive force for 2 minutes.

Table 1. Endodontic filling materials

Material	Manufacturer
Tanari	Tanariman Ind. Ltda., Macapuru, AM, Brazil
Roeko	Roeko, Langenau, Germany
Activ GP	Brasseler, Savannah, GA, USA
Microseal	Analytic Endodontics, Orange, CA, USA
TC System	Tanaka de Castro Ltda., Cascavel, PR, Brazil

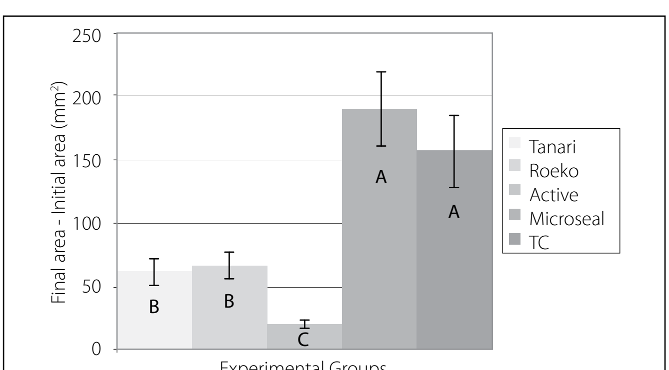

Figure 1. Means (±sd) in mm^2 of the differences between final and initial areas for each filling material. Means with the same letter did not differ significantly from each other ($p > 0.05$).

Digital images of each specimen were obtained before and after compression and examined using an image processing and analysis software (UTHSCSA Image Tool for Windows version 3.0, San Antonio, TX, USA) to determine sample areas in mm^2. The thermoplasticity of each material was determined by the difference between the final and initial areas obtained for each specimen.

Data statistical analysis was carried out by means of analysis of variance (ANOVA) and multiple comparisons among the experimental groups were done by Tukey's post-hoc test. Significance level was set at 5%.

Results

Means and standard deviation for the differences observed between final and initial areas for each specimen are shown in **Figure 1.** Statistical analysis revealed that TC and Microseal gutta-percha had a similar behavior ($p > 0.05$) and reached the highest thermoplasticity results among all assessed samples ($p < 0.001$). Among the gutta-percha cones, Tanari and Roeko presented statistically similar results ($p > 0.05$) and had a better performance ($p < 0.05$) in comparison to Activ Point.

Discussion

Almost 50 years ago, Schilder[1] suggested the need for three-dimensional filling of the root canal system. This method aimed at adequately filling the root canal and its irregularities. While the ability of different techniques to fill root canal irregularities has been extensively assessed, few studies published so far[3,20,21,22] have investigated the thermoplastic properties of different brands and types of gutta-percha.

Due to the low number of studies focusing on the differences between commercially available brands of gutta-percha, no specific methodology for the assessment of the thermoplasticity of these materials has been described. In the present study, the American Dental Association (ADA) specification nº 57 (referring to endodontic sealing materials) and the ISO 6876/2002 standard (*Dental root canal sealing materials*) were adapted for the testing of gutta-percha samples, as previously described[22]. Using a similar methodology, Tanomaru-Filho et al.[22] have shown that Resilon presents adequate thermoplastic properties; the authors concluded by endorsing its use in thermoplastic root canal filling techniques.

According to Gutmann and Witherspoon[2], gutta-percha phase transitions occur when the material is heated or cooled. At a temperature of 46 to 52 ºC, the crystalline structure changes from the beta to the alpha phase; at higher temperatures (56 to 62 ºC), the material changes from the alpha phase into an amorphous form. According to Schilder et al.[15], a minimum temperature of 64 ºC is necessary to plasticize gutta-percha and allow its use in thermoplastic techniques. Venturi et al.[21] investigated three commercial brands of gutta-percha for the filling of accessory canals at different temperatures and observed flow >1.2 mm only when temperatures above 60 ºC were employed. Based on these authors' findings, the temperature of 70 ºC was chosen for the present study.

The results of the present study showed differences among the assessed samples. TC and Microseal gutta-percha (alpha phase) presented the highest thermoplasticity results when considering all samples. Among the gutta-percha cones (beta phase), the Tanari and Roeko samples presented higher thermoplasticity means, with significant differences when compared to Activ Point. The highest thermoplasticity results obtained with TC and Microseal systems are probably related to the thermal treatment that the material is submitted to during the manufacturing process[12], resulting in alpha gutta-percha.

Gutta-percha is a natural polymer that undergoes industrial processing and incorporation of other substances before its application in dentistry. The thermoplastic properties of gutta-percha have been shown to depend directly on its composition, and they are more pronounced in its pure form than in the industrialized version[17]. Other studies have also reported that the amount of inorganic fillers added to the material, as well as the thermal changes induced during cone manufacturing, may affect its properties[16,18,19]. Gurgel Filho et al.[19] chemically and radiographically assessed five commercially available brands of gutta-percha and found differences in material composition that could potentially affect their plasticity. Brands with higher amounts of gutta-percha in their composition showed better results while filling simulated accessory canals[20].

It is important to take into consideration that Activ gutta-percha cones present a glass ionomer coating whose aim is to provide increased bonding to Activ GP sealer, a glass-ionomer filling material recommended by the manufacturer. The presence of a layer of glass ionomer on Activ gutta-percha cones might have been, therefore, responsible for the lower thermoplasticity results observed with this brand.

The present study was carried out using a previously described methodology[22], considered as an initial model for thermoplasticity evaluation. Further research is required to increase the accuracy and standardization of the analysis of the thermoplastic properties of gutta-percha and similar root canal filling materials.

In conclusion, the Microseal and TC gutta-percha presented more adequate thermoplastic properties when compared to the other brands of gutta-percha evaluated in the study, thus endorsing their use in endodontic procedures.

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