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A COMPARATIVE EVALUATION OF THE THERMOPLASTICITY OF DIFFERENT GUTTA PERCHA CONES

MADHURI AGRAWAL[1], SAMEER JADHAV[2], VIVEK HEGDE[3] & SRILATHA S[4]

[1]Post Graduate Student, Department of Conservative Dentistry and Endodontics, M. A. Rangoonwala Dental College and Research Centre, Pune, Maharashtra, India

[2]Professor and Guide, Department of Conservative Dentistry and Endodontics, M. A. Rangoonwala Dental College and Research Centre, Pune, Maharashtra, India

[3]Head of the Department, Department of Conservative Dentistry and Endodontics, M. A. Rangoonwala Dental College and Research Centre, Pune, Maharashtra, India

[4]Reader, Department of Conservative Dentistry and Endodontics, M. A. Rangoonwala Dental College and Research Centre, Pune, Maharashtra, India

ABSTRACT

Aim

To compare the thermoplasticity of different commercially available brands of gutta percha at different compression loads but constant temperature.

Materials and Methodology

Thirty cylindrical specimens measuring 4mm in diameter and 1mm in height were made from each examined brand: dentsply, diadent and sure endo.After 24h, the specimens were placed in water at 80 degree C for 60s.After that specimens were placed between two glass slabs and loads weighing 3.5 and 5.0 kg were applied. Images of the specimens were digitized before and after the test and analyzed using imaging software to determine their initial and final areas. The thermoplasticity of each gutta percha brand was determined by the difference between initial and final areas of the specimens. Data were subjected to ANOVA test at 5% significance.

Results

Data showed higher flow area values for DENTSPLY under both compression loads at 80 degree C.

Conclusions

Different brands of gutta percha requires different compression loads for evaluation of their thermo mechanical properties. For all brands, the greatest flow occurred at 80 degree C under a load of 5.0 kg. Therefore, these parameters may be adopted when evaluating endodontic filling material.

KEYWORDS: Guttapercha, Endodontic Filling Material, Flow

INTRODUCTION

The main objective of root canal filling is to completely fill the pulp cavity in three dimensions .Two factors are important in the three-dimensional filling of the root canal system,namely,the properties of the material employed and the filling technique[13,14,15].Gutta –percha is the filling material more universally approved and used for its properties like biological compatibility,dimensional stability,pliability,easy placement and removal,and radiopacity which are close to the characteristics of ideal filling material[10,20.]

Gutta-percha is a dried coagulated extract produced by trees of the sapotaceae family and mainly derived from *palaquium gutta bail*[2,9]. Gutta-percha is available in two different crystalline forms alpha and beta and may be converted from one form to another. When extracted, gutta-percha is in its natural alpha form; beta is the processed form, ready for use in endodontics[5].Pure gutta percha is rigid at ordinary temperature becomes pliable at 25^0-30^0 C,softens at 60 ^{0} C and melts at 100^0 C with partial decomposition.Its plasticity at a relatively low temperature made it useful in dentistry.

In general,the composition of dental gutta-percha has been shown to be approximately 18 to 22% gutta-percha polymer and 37 to 75% zinc oxide[12].It is evident that the thermoplasticity of gutta-percha cones is affected by their chemical composition, as well as by thermal changes resulting from the manufacturing process and use of these materials[15,21]. Although several endodontic techniques have been evaluated with respect to their ability to adequately fill the root canal and its irregularities, few studies have focused on the thermoplasticity of different brands of gutta-percha cones used in thermomechanical methods.

The present study aims to analyse the thermoplasticity of different commercially available brands of gutta-percha cones(Dentsply,Diadent and Sure endo)at different compression loads and a constant temperature.

METHODS

Samples

Thirty specimens were fabricated. Ten cylindrical specimens (4 mm in diameter, 1 mm thick) were prepared from each examined brand of gutta-percha. Standardized specimens were divided into three groups(n=10).Group I – Dentsply(Dentsply Malliefer),Group II- Sure endo(Sure dent,Korea) and Group III -Diadent(Diadent group International,Korea) Then, each group was divided into three subgroups(n=5),according to the compression load to be applied (3.5 kg or 5.0 kg ,respectively).

For fabrication of the samples, materials were heated at 80 ^{0} C for 60 s, in a thermometer-controlled water bath, then placed in standardized moulds that consisted of a standard metal ring with an inner diameter of 4 mm and a thickness of 1mm. The moulds containing the heated materials were placed between two glass slabs,which were then compressed under a constant and controlled force of 5.0 N for 1 min. After removal from the mould, excess material was excised, using a sharp blade at the outer edges of the disc, and the dimension of each specimen was checked using a digital micrometer with 1 micro m precision (Mitutoyu,Japan). The samples were kept at 25 ^{0} C for 24 h.

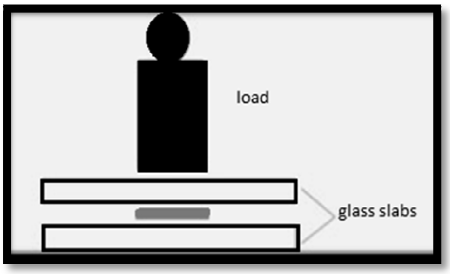

Figure 1: Apparatus to Compress Gutta -Percha

The specimens were again then returned to the heating apparatus at 80°C for 60 s. Each sample was once again positioned between two glass slabs and subjected to a load of 3.5 kg and 5.0 kg, according to each subgroup, for 2 min.The postcompression images were photographed and were examined under a stereomicroscope (Vardhan,India) using an image analysis software (chroma system, India)for comparison between the initial and final areas (in mm2) of each sample. A millimetre ruler was photographed beside the specimen and served as a calibration parameter for the Image Analysisl program during the measurement. The resulting area was obtained by the demarcation of points, circumscribing the outer edge of the image of the specimen. Flow property was determined in mm^2 by subtracting the final (after compression area of each specimen from its original area (before compression).

ANALYSIS OF THE RESULTS

The data were analysed statistically by ANOVA(one way and two way) and multiple comparisons among the experimental groups were done by Tukey's test. The significance level was set at 5%.

RESULTS

Table 1: Resulting Flow Area in mm^2

Groups	Dentsply		Sure Endo		Diadent	
Subgroups	5kg	3.5kg	5kg	3.5kg	5kg	3.5kg
	3.53	2.83	3.01	2.72	2.75	2.26
	3.52	2.92	3.25	2.64	2.84	2.28
	3.81	3.14	3.13	2.59	2.66	2.01
	3.44	2.98	3.17	2.83	2.42	2.94
	3.69	3.04	2.88	2.91	2.91	2.87

Table 2: Mean Diameter in mm^2 when 3.5kg Load was Applied

3.5kg	Number of Samples	Diameter (Mean ± SD)	p-Value
Dentsply	5	2.98 ± 0.12	<0.031
Sure endo	5	2.74 ± 0.13	<0.031
Diadent	5	2.49 ± 0.40	<0.031

Table 3: Mean Diameter in mm^2 when 5kg Load was Applied

5kg	Number of Samples	Diameter (Mean ± SD)	p-Value
Dentsply	5	3.60 ± 0.15	< 0.001
Sure endo	5	3.09 ± 0.14	<0.001
Diadent	5	2.72 ± 0.19	<0.001

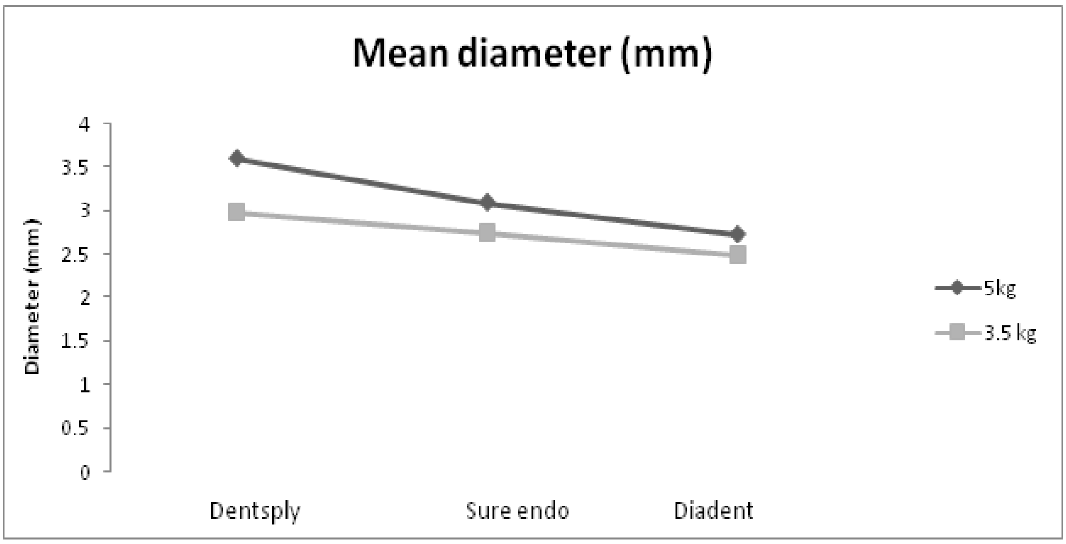

Figure 2: Comparison of Mean Diameter with Respect to 3.5 kg and 5 kg in Dentsply Group, Sure Endo Group and Diadent Group

DISCUSSIONS

Gutta percha for root canal filling is a composite material. The main components reported in previous studies were zinc oxide, pure gutta percha (trans-1, 4-polyisoprene), wax or resin as plasticizer and barium sulphate. The findings of preliminary studies showed that the force required to provide a significant increase in the diameter of heated gutta-percha specimens should be greater than 3.5 kg[16,17]. In the present study, a 5-kg weight was used. Venturi *et al.* investigated three commercially available brands of gutta-percha in accessory canals at different temperatures, and found that material flow greater than 1.2 mm occurred only at temperatures higher than 60°C. Based on the findings of these studies, a temperature of 80°C was chosen for the present study[19].

Three gutta-percha brands were tested in this study. The thermomechanical property of materials is indirectly evaluated by subtracting the final from the initial areas of samples subjected to compression at a constant temperature. The present study was designed to determine compression loads (3.5kg and 5.0 kg) would significantly alter the performance of root canal filling materials in terms of flow.

The results from the present study indicate that: at 80^0 C and under a compression load of 5.0 kg, different samples showed significant differences in area, allowing comparison between the materials. As the results under the different experimental conditions were poorly corsrelated, few differences were observed when the flow of the materials was compared. In addition, considering the lower regression coefficients observed, the results of the materials could not be predictable from one to the other. Therefore, it is suitable to select parameters of temperature and load in which the differences amongst the results of thermoplasticity of the materials could be more evident.

When testing the heated materials, the relationships between temperature (^{0}C), load (kg) and differences in area before and after compression (mm^2) were observed. Although the results demonstrated that testing with a load of 5.0 kg at 80^0C promoted significant area changes in the materials analysed, when a 5.0 kg load was applied. The evaluated materials were kept in water at 80^0 C for 60 s according to previous studies. The results demonstrated that all three brands evaluated (dentsply,diadent and sure endo) have thermoplastic ability. Dentsply showed significant thermoplastic ability at 80 ^{0} C, even under lower compression loads (3.5 kg).

The thermomechanical ability of gutta-percha is directly dependent on its composition; this phenomenon is more evident in its pure form than in industrialized versions[11].Other studies have also reported that the amount of inorganic substances added during the manufacturing process can affect the thermoplastic properties of gutta-percha cones[1,6] ..In the present study,Dentsply demonstrated significantly higher thermoplastic ability than its conventional counterpart, which suggests the presence of a greater percentage of gutta-percha in its formulation. Results from a previously conducted chemical and radiographic analysis of five brands of gutta-percha showed wide variation in the percentages of zinc oxide (from 84.30 ± 0.50% to 66.50 ± 0.50%) and of gutta-percha (from 14.5 ± 0.70% to 20.4 ± 0.40%) in their formulations 6.In another analysis of the same commercial brands of gutta-percha cones [7] verified that those containing greater amounts of gutta-percha were more capable of filling simulated lateral canals by thermatic compaction.

CONCLUSIONS

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

- Different brands of gutta-percha cones require different compression loads for evaluation of their thermomechanical properties.

- For all gutta-percha the greatest flow occurred at 80^0 C under a load of 5.0 kg; therefore, these parameters may be adopted when evaluating endodontic filling materials.
- Dentsply showed the greatest flow both under a load of 3.5 kg and 5kg.

Further research is required to increase the accuracy and standardisation of the analysis of the thermoplastic properties of gutta-percha and similar root canal filling materials.

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