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Research Article

In Vitro Analysis of the Temperature of Two Thermal Agents: Ice Stick and Heated Gutta-Percha Stick

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Abstract

Thermal tests of cold and heat are semiological resources coadjuvant to professional experience, helping to determine the pulp condition. However, thermal variations may compromise the diagnostic fidelity. The purpose of this study was to analyze in vitro the temperatures of ice sticks and heated gutta-percha sticks using a digital thermometer. The temperature of both materials was measured by simply touching the thermocouple, recording the temperature on the digital display of the device. Thirty-six ice sticks were produced in a freezer from anesthetic tubes filled with water. The gutta-percha rods were heated directly over an alcohol lamp. The temperatures of the gutta-percha stick showed greater variations than those obtained in the tests with the ice stick. The temperatures with the gutta-percha stick varied between 90.20°C (194.3°F) and 146.10°C (294.9°F), corresponding to an average temperature of 114.08°C (237.3°F). The temperature obtained from the ice stick, observed in 36 trials, was 1°C (33.8°F) and, in 14 situations, the temperature was 2°C (35.6°F), with an average temperature of 1.28°C (34.3°F). Therefore, the ice stick shows less dissimilar temperature variations than the heated gutta-percha stick. There were no thermal variations from the numerical point of view in relation to obtaining the temperatures of the thermal test by cold using the ice stick, while there were temperature variations and differences in number when the tests performed with the heated gutta-percha stick.

***Keywords:** Dental pulp tests; Ice; Gutta-percha; Heating.*

Introduction

In addition to the clinical endodontic examination, other adjuvant resources for evaluation and determination of the clinical diagnosis of the pulp status are necessary. The pulp sensitivity tests are of great value[1-10]. Among the pulp sensitivity tests are the electrical and thermal tests. Generally, thermal tests are chosen, by cold and heat, since they are simpler, faster, practical and clinically more effective[1,3,6,11-16].

The practicality of the use of the thermal test by cold is presented by means of ice, generally made in anesthetic tubes. The cold test also allows assessing the degree of reversibility of the inflammatory process, important in planning endodontic treatment[15,17].

On the other hand, the application of the heat test has always been harshly criticized, mainly due to the expectation of producing false-negative results, attested by the difficulty in controlling the high temperature during its application, besides the intense pain in these reported situations[1,18].

Clinically, the possibility of temperature variation must be observed, particularly in heat and cold tests, which may promote doubtful results in relation to the responses of the algic process[17,19-22]. Temperature variations may, if they persist for longer (more than 5 seconds), result in damage to the healthy pulp[1,20].

The purpose of this investigation was to ascertain (in vitro) the temperatures using a digital thermometer of two thermal agents, the ice stick and the heated gutta-percha stick.

Material and Methods

Fifty tests were performed using two thermal agents: ice sticks and heated gutta-percha sticks.

For each type of thermal agent, the tests were repeated, totalizing 100 tests, 50 for the ice stick and 50 for the heated gutta-percha stick.

Ice sticks were obtained by means of empty anesthetic tubes that were filled with water and taken to the freezer. After water solidification, the ice sticks were removed by friction with the palms of both hands (Figure 1).

In turn, the gutta-percha stick was heated in the flame of an alcohol lamp and two moments were important for the test: one in which the operator's index finger and thumb held the stick until he felt it was hot; and the other moment in which the gutta-percha stick suffered a flexion of its tip (Figure 2).

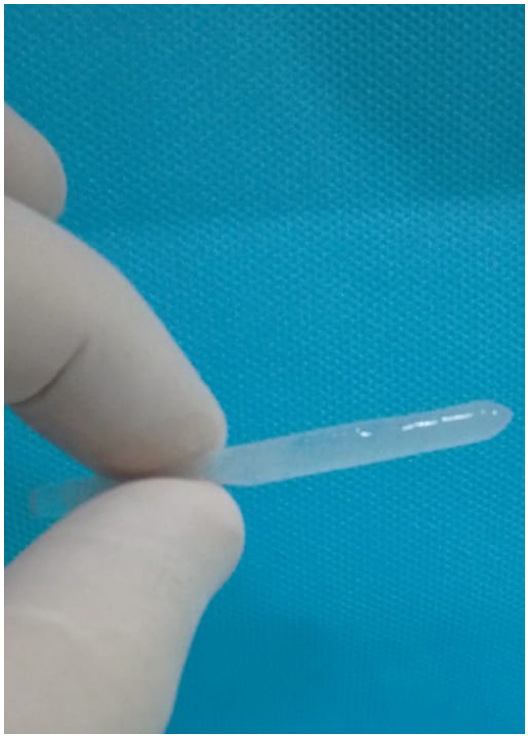

Fig. 1: *Ice stick.*

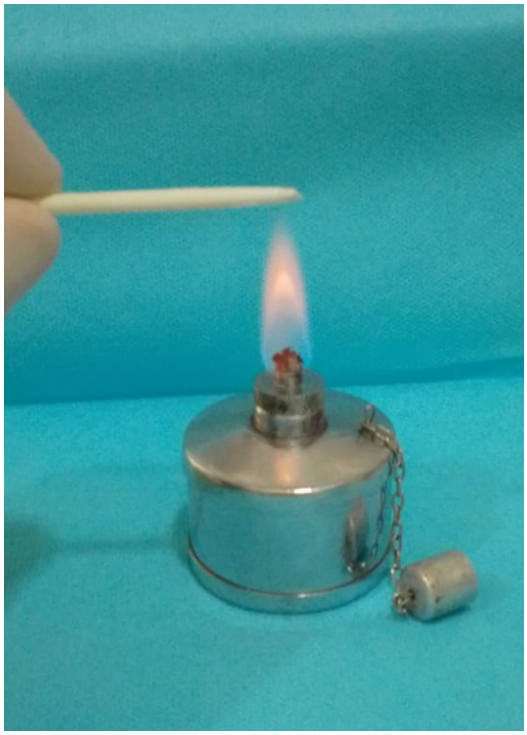

Fig. 2: *Heated gutta-percha stick.*

After the preparation of the two methods cited above, the surface of these two thermal agents was immediately taken to the thermocouple. All measurements in the apparatus were performed in degrees Celsius (°C) (Figure 3) and converted into degrees Fahrenheit (°F). The apparatus was initially calibrated with room temperature.

Initially, the temperature of the ice sticks was recorded (Figure 4) and, subsequently, the tests with the gutta-percha stick (Figure 5). When the maximum temperature decrease occurred, the HOLD function button of the thermometer located below the apparatus was actuated to maintain this maximum temperature decrease, except that it was recorded in the digital display of the thermometer in the form of a number, value in a spreadsheet (Figure 6). Similarly, at the moment when the maximum temperature of the heated gutta-percha rod occurred, the HOLD function button of the thermometer was actuated to maintain this maximum temperature increase saved in the digital display of the thermometer in the form of a number, noting this value in a table.

The results were tabulated performing descriptive statistical analysis using a table, mean, standard deviation, coefficient of variation to show the behaviour of the collected data and as statistical inference, confidence intervals at 5% level, used to show the true mean temperature of the thermal agents.

Fig. 3: *Thermocouple activated.*

Fig. 4: *Ice stick at thermocouple tip.*

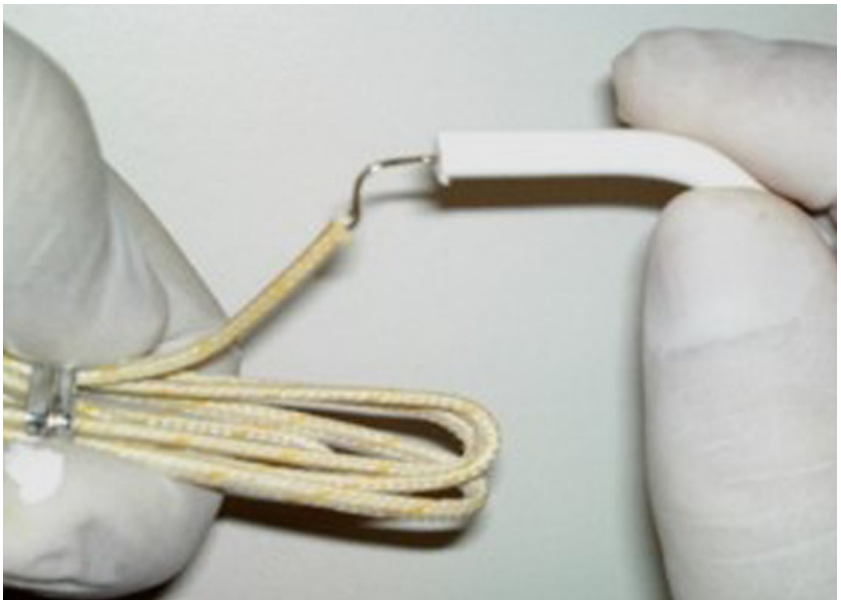

Fig. 5: *Gutta-percha stick heated to the thermocouple tip.*

Fig. 6: *Thermocouple with HOLD button activated.*

Results

The values obtained in the temperature measurements of the ice sticks and gutta-percha sticks are presented in Table 1.

The temperature of the gutta-percha sticks varied between 90.2°C (194.3°F) and 146.1°C (294.9°F), corresponding to a mean temperature of 114°C (237.3°F) and a standard deviation of 10.4°C (50.8°F). From these results, the Coefficient of Variation (CV) was 10.45%, indicating the existence of homogeneity in the values collected.

Regarding the temperature of the ice sticks, Table 1 shows that in 36 tests the observed temperature was 1°C (33.8°F) and in 14 situations, the temperature obtained was 2°C (35.6°F), corresponding to an average temperature of 1.28°C (34.3°F) and standard deviation 0.45°C (32.8°F). With these results, the Coefficient of Variation (CV) was 35.43%, showing the existence of heterogeneity in the values collected.

In view of the results, it was concluded that the ice sticks presented temperatures more different from each other than the gutta-percha sticks.

As a statistical inference, the confidence interval at 5% significance level indicated that the true mean temperature of gutta-percha sticks is between 110.7°C (231.2°F) and 117.3°C (243.1°F) and of ice sticks between 1.1°C (33.9°F) and 1.4° C (34.5°F).

Table 1: Mean (×), Standard Deviation (σ), Coefficient of Variation (CV), highest and lowest value when comparing the test with ice stick and heated gutta-percha stick in relation to the magnitude of temperature (°C/°F).

	x (°C/°F)	σ (°C/°F)	CV (%)	Highest valor (° C/°F)	Lowest valor (°C/°F)
Ice stick	1.28 / 34.3	0.45 / 32.8	35.43	2 / 35.6	1 / 33.8
Heated Gutta-Percha stick	114 / 237.2	11.9 / 53.4	10.45	146.1 / 294.9	90.2 / 194.3

Discussion

The diagnostic evaluation of the dental pulp condition during patient examination is, most of the times, a difficult task. The use of complementary resources can help the dental surgeon, by means of tests that provide answers about the integrity or not of the pulp tissue. Several clinical occurrences, such as teeth with chromatic alteration of the crown, traumatized teeth, teeth with excessive orthodontic traction or those with caries process, teeth that denote periodontal damage and/or periapical bone rarefaction, can require pulp sensitivity tests[11].

The semiotechnical method most used in the evaluation of pulp sensitivity by the dental surgeon is the thermal stimulus, particularly the use of ice sticks and heated gutta-percha[1,14,15]. Although the ice stick is widely used[3,4], there are situations in which this agent becomes imprecise, such as teeth with incomplete rhizogenesis[8]; teeth with great deposition of reparative dentine[9]; and dental elements with total crowns[6]. In these situations, the use of cooling gas is recommended, which actually promotes greater cooling.

Pain caused by thermal stimulation is one of the most common symptoms[16]. Cold stimulation can cause or relieve pain, depending on the temperature[4,15,22]. On the other hand, thermal testing can help to accurately locate the origin of the tooth with painful process[4,15,16,22].

In comparison with other agents used in thermal tests, ice stick and cold water presented lower thermal variations in relation to the cooling gas dichlorotetrafluoroethane. In the same perspective, hot water presented greater temperature variation in relation to heated gutta-percha[19,20]. Thermal stimuli are subject to variations depending on the temperature of the stimulus, the rate of heat transfer to the tooth and the extent of temperature change within the tooth structure[21].

In the present study, the temperatures measured in the ice stick test varied little. In 14 situations, the temperature of the ice sticks was 2°C (35.6°F), while in 36 tests temperatures of 1°C (33.8°F) were obtained. The possibility of false negative results should also be considered, since the temperature of the oral cavity varies from 36°C to 37°C (96.8°F to 98.6°F). The use of the ice stick may not determine the presence of a positive response [2,3,5-10,14]. Therefore, it is recommended to repeat the thermal test with the ice stick at least twice, especially when the tooth does not respond to the test in the first application[14]. This repetition does not imply damage to the pulp tissue, precisely because there is not enough time to cause lesions[17].

Similarly, heated gutta-percha can reach the range between 120°C (248°F) and 150°C (302°F)[18]. In the present investigation, the temperature range was between 90.2°C (194.3°F) and 146.10°C (294.9°F), with an average of 114°C (237.2°F). The heated gutta-percha stick was determined as an imprecise thermal stimulus, aggressive and of difficult control, and that by the necessary repetition until pulp diagnosis, can cause high temperatures to the dental pulp [15,20]. However, Tavares[18] presented the mean intrapulpal temperature was 25.60°C (78°F), during 5 seconds of application. In practice, the heating of the gutta-percha stick should be based when the dental surgeon feels the heating of the finger, or when the stick bends after heating.

Conclusions

Based on the results obtained and the methodology used in this experiment, it is deduced that the heated gutta-percha sticks presented more different temperatures than the ice sticks. There were no thermal variations from the numerical point of view in relation to obtaining the temperatures of the cold thermal test using the ice sticks. On the other hand, there were temperature variations and number differences when the tests were performed with the heated gutta-percha sticks.

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