# Comparison of Heat-testing Methodology

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## Abstract

**Introduction:** Patients with irreversible pulpitis occasionally present with a chief complaint of sensitivity to heat. To appropriately diagnose the offending tooth, a variety of techniques have been developed to reproduce this chief complaint. Such techniques cause temperature increases that are potentially damaging to the pulp. Newer electronic instruments control the temperature of a heat-testing tip that is placed directly against a tooth. The aim of this study was to determine which method produced the most consistent and safe temperature increase within the pulp. This consistency facilitates the clinician's ability to differentiate between a normal pulp and irreversible pulpitis. **Methods:** Four operators applied the following methods to each of 4 extracted maxillary premolars (for a total of 16 trials per method): heated gutta-percha, heated ball burnisher, hot water, and a System B unit or Elements unit with a heat-testing tip. Each test was performed for 60 seconds, and the temperatures were recorded via a thermocouple in the pulp chamber. Analysis of the data was performed by using the intraclass correlation coefficient. **Results:** The least consistent warming was found with hot water. The heat-testing tip also demonstrated greater consistency between operators compared with the other methods. Hot water and the heated ball burnisher caused temperature increases high enough to damage pulp tissue. **Conclusions:** The Elements unit with a heat-testing tip provides the most consistent warming of the dental pulp. *(J Endod 2012;38:1106–1109)*



## Key Words

Electronic probe, gutta-percha, injury, thermocouple, tooth


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Inflammation of the dental pulp often results in allodynia and hyperalgesia, sometimes causing the pulp to become hypersensitive to temperature changes (1). Occasionally, patients will present for endodontic treatment with a chief complaint of heat sensitivity. Several techniques have been used in dental practice to create warming of the dental pulp to establish whether a particular tooth is sensitive to heat. The use of friction, heated gutta-percha, hot water, or a heated instrument has been previously described (1–17).

False negatives and positives might occur with heat testing. For example, a nonsensitive response to heated gutta-percha only detected a necrotic pulp 48% of the time (14), whereas 83% of the positive responses correctly identified vital teeth. Heat-sensitive teeth range anywhere from 30%–57% with pulpitis (1, 8) and from 0%–96% with normal pulps (7, 12). This suggests that heat testing should be further refined.

Various heat-testing methodologies often lack consistency from one use to the next. With hot water, a nonuniform application over a tooth could result in variable pulpal temperature changes. Heated gutta-percha use has reported temperatures from 90°C–150°C (1, 9, 10). Others have reported difficulty with false-negative responses because of considerable heat loss within the gutta-percha before it could be applied to a tooth (11), and normal teeth can be nonsensitive to heat, whereas other normal teeth give severely painful responses despite efforts to standardize the application of the gutta-percha (13).

Heat testing can damage pulp tissues. Lundy and Stanley (11) expressed concern that a heated ball burnisher might damage the pulp or burn other intraoral tissues. A temperature of 42°C–42.5°C applied to dentin can be high enough to cause damage to the pulp of rat incisors (18). An intrapulpal temperature rise of only 4°C caused minimal temporary changes in the pulp tissue of monkeys, but a temperature rise of 10°C caused greater damage, and increases of 20°C were able to cause necrosis within the pulp (19). Excessive heat applied to the tooth may also damage the surrounding periodontium and bone as seen in the rabbit model (20).

The purpose of this study was to evaluate electronic heat-testing instruments in warming a tooth and to compare these instruments with more traditional heat-testing methods for consistency, safety, and potential for clinical effectiveness.

## Materials and Methods

Five different heat-testing sources were selected for comparison: the electronic tip on the Elements unit, the electronic tip on the System B unit, heated pellets of gutta-percha, a heated ball burnisher, and water warmed to 60°C. Each of the heat sources was applied to the test tooth for a period of 60 seconds, with the pulpal temperature recorded during this period. A repeated-measures model was designed by using 4 different operators and 4 different extracted teeth where each heat source was applied to each tooth. This resulted in 16 trials for each heat source.

Four nonrestored, previously extracted, fully formed maxillary first premolars were selected for the experimentation. Temperature measurements were accomplished through the use of K-type thermocouples attached to a Fluke 50 Series Thermocouple Thermometer Dual Input with Datalogging (Cole Parmer, Vernon Hills, IL). Each tooth had a K-type thermocouple (1.5 mm × 1 mm) placed into the pulp chamber against the buccal wall (Fig. 1). This location was chosen so the quickest and largest increase in pulpal temperature could be measured, allowing for a determination of which methods produced rapid heating and could potentially cause pulpal damage. Before installation, the thermocouples were tested for accuracy and consistency. Placement within the pulp chamber was achieved by drilling a hole (2-mm diameter) into the middle of the

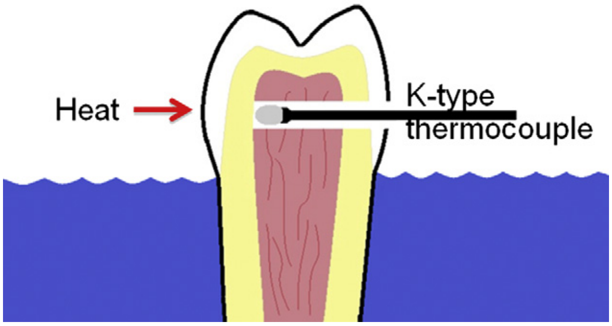


**Figure 1.** Tooth setup for temperature measurements.

coronal pulp from the lingual side of the crown. The thermocouple was inserted into the pulp and advanced until it contacted the buccal wall of the pulp chamber. No attempt was made to remove any existing pulp tissue. Each thermocouple was then secured to the tooth by using cyanoacrylate. To simulate the heat sink that normal periradicular tissues would provide in a clinical situation, the teeth were mounted at the cemento-enamel junction (CEJ) within a water bath, and water was maintained at 37°C by using a recirculating water pump with temperature control (Neslab IC515; Neslab Instruments, Newington, NH) placed inside the water bath.

Each of the heat sources, with the exception of the hot water, was applied to the middle of the facial surface of the experimental teeth. As the tooth was being warmed, the readouts from the multimeter and digital stopwatch were videotaped to record the data. Before each test, the temperature of the tooth was allowed to stabilize to the baseline temperature, and any testing instrument was also allowed ample time to cool to room temperature.

## Gutta-percha

A gutta-percha pellet was heated in a gas flame until it just began to smoke or slump, as previously described by several authors (1, 3–5, 9, 10, 12, 13, 16, 21). The warmed gutta-percha was then applied to the mid-facial surface of the test tooth and held in place for 60 seconds.

## Heated Ball Burnisher

A #29 ball burnisher instrument was heated in a flame until it just slightly began to glow red (11). Once it began to glow, it was immediately removed from the flame, and the operator held the instrument in

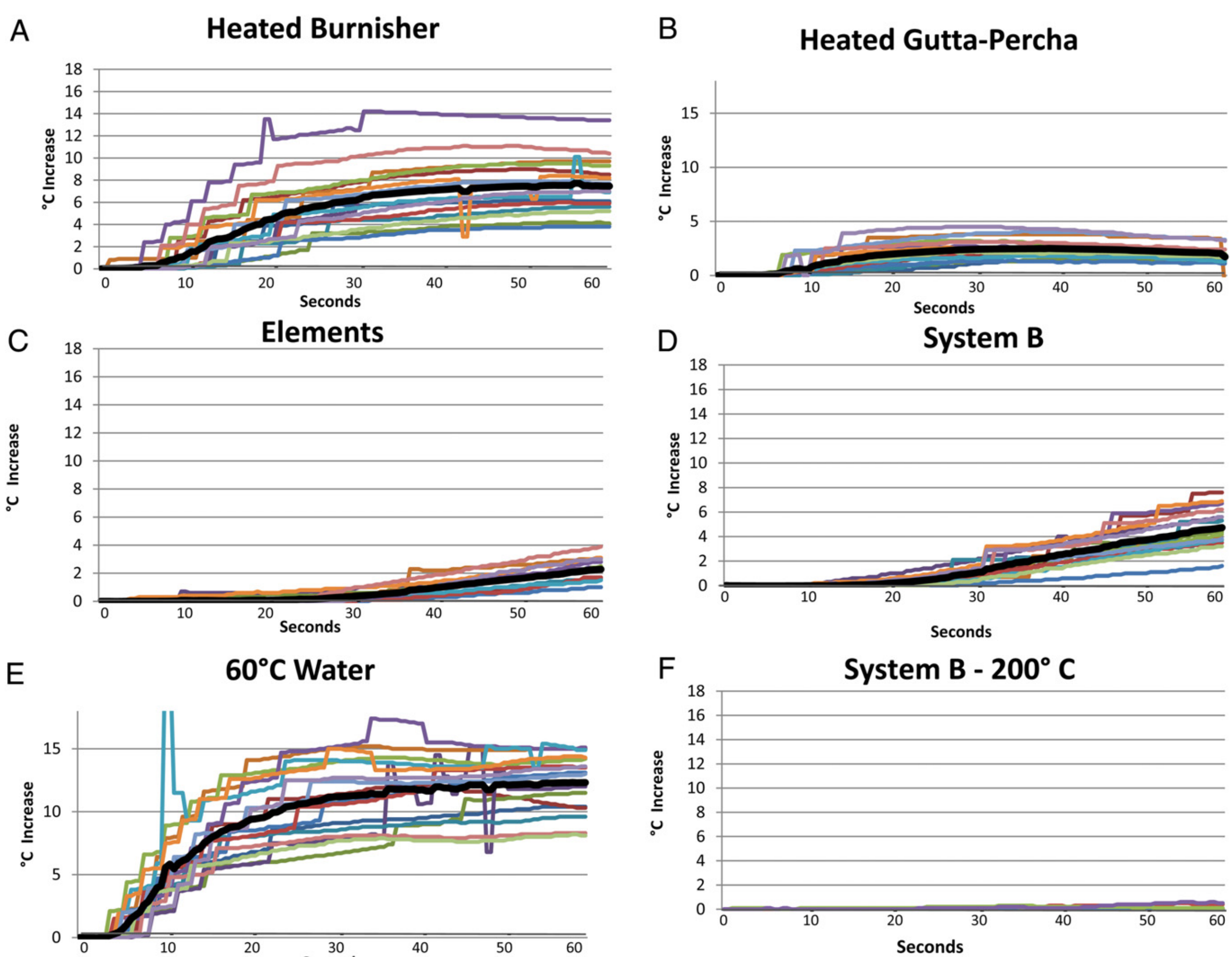


**Figure 2.** (*A*) Heated ball burnisher recorded data. (*B*) Gutta-percha recorded data. (*C*) Elements unit recorded data. (*D*) System B unit recorded data. (*E*) Hot water recorded data. (*F*) System B unit recorded data. Instrument set at 200°C. *Black lines* indicate the means of the 16 individual tests.