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The Impact of Temperature and Tooth Type on Pulp Chamber Heating During Endodontic Thermal Diagnostics: An In Vitro Study

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Introduction

Various heat-testing methods, such as the use of heated gutta-percha, instruments, hot water, or friction-induced heat—often deliver inconsistent temperatures, highlighting the critical need for standardization. In contrast, devices employed in warm gutta-percha techniques, which provide a specific and controlled temperature output, can offer a more reliable approach to testing. Nevertheless, thermal tests in endodontic diagnostics may raise the temperature within the pulp chamber, posing a risk of damage to the vital pulp or surrounding periodontium. This in vitro study investigated the relationship between temperature output and tooth type in reaching a 5°C threshold increase.

Materials and methods

Forty-five extracted teeth (9 lower incisors, 9 canines, 13 premolars, 14 molars) were used. A thermal probe was placed in the pulp chamber through a 2 mm hole on the oral side, sealed with thermal paste, and teeth were fixed in a 37°C water bath (Figure 1 and 2). Heat from a Fast Pack (Eighteeth Co., China) was applied via a fine medium plugger (50/0.05) to the vestibular surface for 30 seconds at 250°C, 150°C, and 90°C. Temperature changes were recorded over 55 seconds using the "Testo Smart App.„. Statistical analysis was conducted using Analysis of Variance ANOVA.

Figure 1. An experimental setup consisting of a tooth submerged in a water bath maintained at 37°C, with a temperature sensor connected to a smartphone application for real-time temperature monitoring

Figure 2. Schematic diagram of placing the probe for measuring the temperature in the chamber and applying heat to the surface of the tooth

Results

Temperature changes in the pulp chambers of different tooth types during heat application at 90 °C, 150 °C, and 250 °C are shown on figures 3, 4 and 5.

At 90°C, 67% of lower incisors, 0% of canines, 23% of premolars, and 7% of molars reached the critical temperature of 5 °C.

At 150°C, critical temperatures were achieved in 89% of lower incisors, 67% of canines, 77% of premolars, and 36% of molars.

At 250°C, 100% of lower incisors, 89% of canines, 100% of premolars, and 71% of molars reached the threshold (Figure 6).

The differences in the time required for the samples to heat up to the critical 5°C are statistically significant at a temperature of 250°C and 150°C ($p < 0.001$), but not at 90°C due to low number of specimens that reached critical temperature.

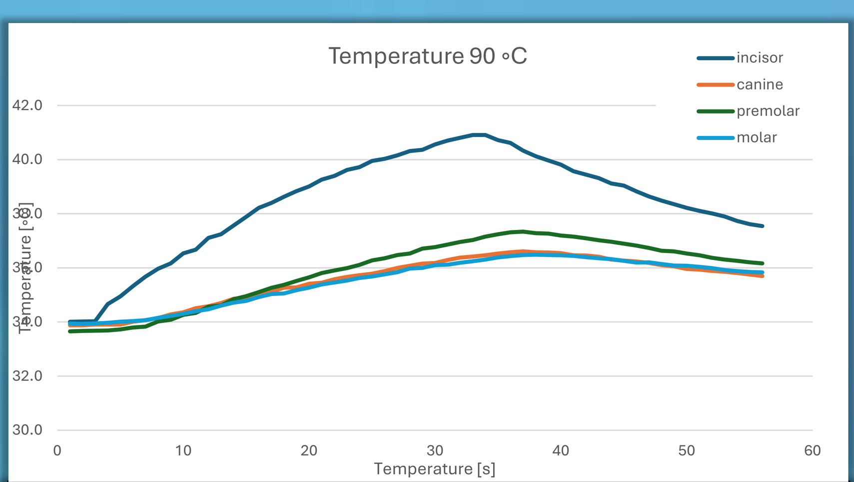

Figure 3. Temperature changes in the pulp chambers of different tooth types during heat application at 90 °C.

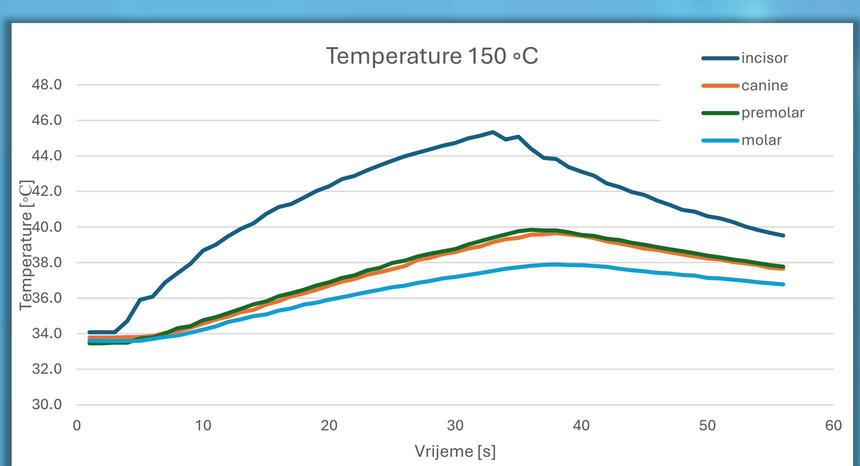

Figure 4. Temperature changes in the pulp chambers of different tooth types during heat application at 150 °C.

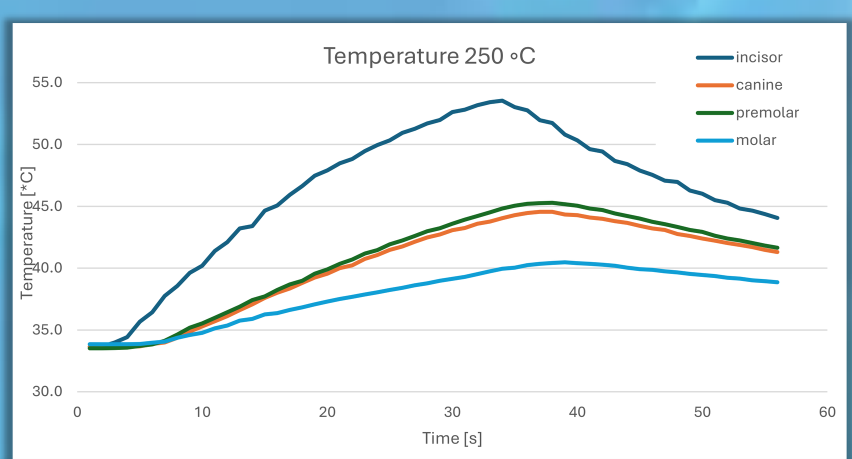

Figure 5. Temperature changes in the pulp chambers of different tooth types during heat application at 250 °C.

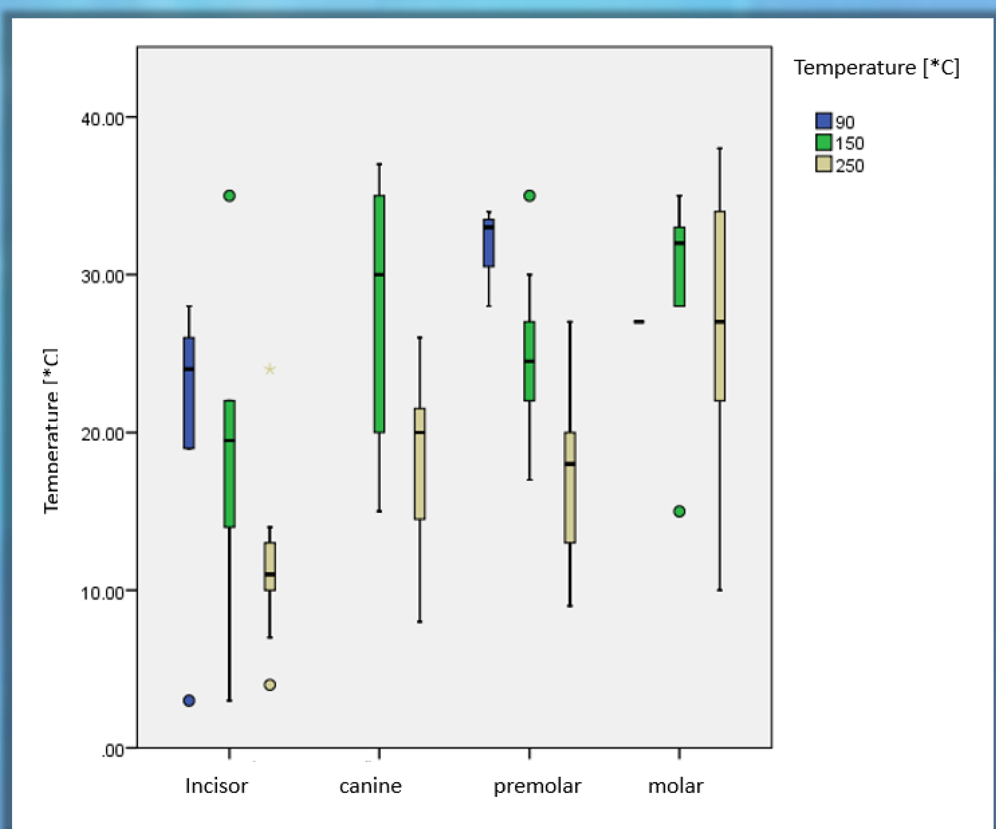

Figure 6. Time to reach the critical temperature depending on the type of tooth and the temperature.

Conclusion

These findings emphasize the need to consider tooth type and temperature settings in thermal diagnostics to reduce risks of pulp damage. Further research with larger samples is recommended to refine clinical guidelines.

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