G12 Macroscopic and Microscopic Changes of Dental Tissues Exposed to Thermal Radiations: Forensic Interest in Fire Disaster Modeling

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After attending this presentation, attendees will better understand how dental tissues could help investigators in fire disaster modeling involving victims.

This presentation will impact the forensic science community by describing the findings from an experimental study conducted in association with the Section of Engineering Fire in the Central Laboratory of Police of Paris (LCPP), France. The benefit of this study lies in its novelty, as dental tissues were the first organic tools used in fire modeling. These findings could be used in fire disasters involving victims.

Human teeth reveal important features that demonstrate their ability to withstand postmortem shock caused by thermal activities. When bodies are seriously damaged by fire, the role of the forensic odontologist becomes even more essential during the identification process. This study was conducted in association with the Section of Engineering Fire in the LCPP using specific tools: the Calorimetric Cone (CC) and the Thermo Gravimetric Analyzer (TGA), which work in fire disaster investigations by using inorganic burned materials found at the fire scene.

The main goal of this study was to analyze the physico-chemical changes of the tooth when exposed to different thermal radiations. Both macroscopic (using CC) and microscopic (using TGA) changes were analyzed to define the mass-loss rate of dental tissues. This work sought to provide a new tool to help the LCPP investigators in fire disaster scenarios involving victims.

Material and Methods: This study used 33 samples of healthy teeth; 66 samples of dental tissues (enamel, dentine, and cementum) were collected from these 33 teeth.

For the microscopic study (TGA), the first study used three teeth and six samples of dental tissues to determine the repeatability and reproducibility of the TGA settings. Then, the healthy samples of dental tissues were burned and weighed from temperatures ranging from 25° to 1,000°C with a heating rate of 10°C/min.

For the macroscopic study (CC), teeth were divided into six groups of four teeth each and placed into six plates in order to reproduce the physiological environment of human teeth surrounded by alveolar bone. These plates were exposed to different thermal radiations from 5kW/m2 to 95kW/m2, corresponding to internal temperatures of 100° to 600° in the dental tissues. The exposure time for each plate was 30min, which represented the mean time of fire in Paris. Macroscopic changes of the teeth when heated were recorded using four photographies taken at T=0 ; T=10 ; T=20 ; and T=30 minutes. Then, samples of dental tissues from these burned teeth were collected, and another microscopic analysis was performed to compare the difference of the mass-loss rates between virgin and burned dental tissues.

Results: The microscopic study found that enamel does not lose mass when heated due to its strongly mineralized histological structure; however, on virgin samples, the cementum and dentin demonstrated three main reactions of mass loss: 280°C-400°C; 360°C-500°C; and 650°C-800°C, with the highest peak of mass loss found at 370°C.

For the macroscopic study, the results revealed a dislocation of the dental crown between the enamel and the underlying dentin at approximately 350°C. The external dislocation of the enamel crown could be linked to the internal mass loss of the cementum/dentin that appears at approximately 370°C.

Given the good repeatability of the experiments conducted with the Scientific Police Laboratory, the findings are promising in the fire investigation field involving victims. From now, dental tissues have a thermograph available in the LCPP with a mass-loss rate recorded according to the temperature of fire exposure. The tooth can be considered as a comparison point for further investigations in fire disaster modeling.

The human tooth is the first organic indicator of fire modeling used in the scientific police investigation and could be used in mass disaster fire cases involving victims. Moreover, the distance between the fire source and a victim would also be possible to estimate using the modelization system in the LCPP.

Fire Disaster Modeling, Forensic Odontology, Dental Tissues