Study of macroscopic and microscopic changes of dental tissues under the influence of thermal radiations: forensic interest in the modeling of a fire disaster

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ABSTRACT

Human tooth shows important features attesting its high ability to withstand post-mortem shocks 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 carried out in association with the Section of Engineering Fire in the Central Laboratory of Police of Paris (LCPP) using specific tools : the Calorimetric Cone(CC) and the ThermoGravimetric Analyzer(TGA).

The main objective of this study was to analyse the physico-chemical behaviours of the tooth when submitted to different thermal radiations: both macroscopic (using CC) and microscopic (using TGA) to define the macroscopic changes and the mass loss rate of dental tissues. This work intended to provide new tools to help investigators in the evaluation of fire scenarios.

Material and Methods: 33 samples of healthy teeth and 66 samples of dental tissues were collected from these 33 teeth. For the microscopic study (TGA), first study used 3 teeth and 6 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 25° to 1000°C with a heating rate of 10°C/min.

For the macroscopic study (CC), teeth were divided into 6 groups of 4 teeth and placed into 6 plates in order to reproduce the physiological dental environment of human teeth surrounded by alveolar bone. These plates were placed under different thermal radiations from 5 to 95 kW/m2 corresponding to internal temperatures in dental tissues of [100-600°]. The time of exposure was 30min which represents the average time of a fire in Paris. For each group, 4 photographies were taken at [T=0 ; 10 ; 20 ; 30 minutes] to characterize the macroscopic changes of the teeth when heated. Then, samples of dental tissues from these burned teeth were collected and another microscopic analysis were carried out to compare the difference of the mass loss rates between virgin and burned dental tissues.

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

For the macroscopic study, the results showed the dislocation

between the enamel crown and the underlying dentin around 350°C. The external dislocation of the enamel crown could be linked to the internal mass loss of the cementum/dentin that appears around 370°C.

Given the good repeatability of the observations made on the experiments, the results found are promising in the fire investigation field. Human teeth can be considered as a comparison point for further investigations in the LCPP. Teeth become the first organic indicator of fire modelling used in the scientific police investigation and could also be used in the case of fire mass disaster.