H68 The Effects of Heat and Explosions on Forensic DNA Analyses

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Learning Overview: After attending this presentation, attendees will see the results of a four-year-long project that was completed in July 2019. This presentation includes specific temperature treatments that are required to produce partial DNA profiles from biological stains, the different effects on DNA that are caused by different types of explosions, and how the strength of such evidence (partial profiles) is affected. Attendees will also see how such challenging samples were analyzed through both the conventional capillary electrophoresis technique and massively parallel sequencing.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by describing what may occur to biological evidence in cases that involve fire, explosions, or other sources of high heat. The samples were chosen to reflect realistic situations in which the identification of both victims or suspects is required. The community will also assess the uses and limitations of applying capillary electrophoresis-based methods or massively parallel sequencing to such a challenging type of casework.

This project explores the effects of high temperatures and explosions on DNA samples of forensic value. This project aims to determine the conditions under which biomaterials may degrade in accidental disasters, bombings, and/or crimes involving fire, and how degradation affects interpretation. The experiments were designed to reflect situations requiring victim and suspect identification, and thus involved testing various human samples, including blood and saliva stains. Some samples were heated under laboratory conditions, while others were attached to pipe bombs and detonated outdoors with the assistance of United States police bomb enforcement officers. A sensitive mitochondrial DNA multiplex system was devised and successfully used to detect DNA degradation prior to more costly analyses. Capillary electrophoresis-based Short Tandem Repeat (STR) typing and massively parallel sequencing were compared in terms of their performance on degraded DNA. Treatment at 180°C for 30 minutes was required to induce the first signs of DNA degradation in dried blood and saliva stains, reflected by reduced post-Polymerase Chain Reaction (PCR) DNA detection or drop-out of longer amplicons. There were no interpretable DNA products when heat treatment increased to 200°C. Similar degraded DNA effects were observed in 27% of stains placed on and within smokeless powder-charged pipe bombs, but no sign of degradation was observed with the more energetic C4 explosive, probably because of the shorter duration of heat exposure.

DNA degradation poses challenges to the interpretation of retrieved genetic data. These challenges were investigated both in real profiles from heat-treated samples and in simulated data. In addition, a real case of an unidentified male victim (the Blazing Car Murder, 1931) was analyzed. The combination of real and simulated data provided realistic scenarios, but also allowed control of parameters that affect evidential strength, such as population size and diversity, through lowering of the likelihood ratio and increasing the number of random matches in a database.

DNA Degradation, Partial Profiles, Extreme Conditions

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