F25 Analytical Survey of Restorative Resins for Forensic Purposes: Elemental Composition and Microstructure

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The goal of this presentation is to provide the forensic community with a comprehensive survey of the elemental composition and microstructure of the prominent restorative resins on the market today. It has been demonstrated that restorative resins can be detected by elemental analysis and that they can persist and be recognizable even in extreme conditions such as cremation. Attendees will learn how knowledge of elemental composition and microstructure can help determine brand or brand group of material used and how this information can be a valuable aid in identification.

This presentation will impact the forensic community and/or humanity by providing baseline data for comparison and classification of the prominent restorative resins currently on the market. Historical resins will also be discussed. The data produced is for reference and is in a form reproducible in laboratories worldwide.

Occasionally the odontologist will be called upon to identify a victim under difficult circumstances. Such circumstances include, but are not limited to, fragmented, or incinerated remains. In these cases the structural relationship of the dentition may no longer be intact, making traditional methods of identification problematic. In these situations, the odontologist should be aware of alternative means that can be available to aid in identification. One such method is the ability to recognize resin brand, or brand group.

In situations involving incineration, the amount of destruction will be dependent on the duration and heat of the fire. When a body has been incinerated to the point of cremation, all of the organic material is destroyed. When all that is left is fragmented calcined bone and teeth, identification can only be made from the non-biological artifacts that remain. It is well known that dental prosthesis will be recoverable from such extreme situations, but it is now established that dental resins are retrievable and still identifiable by brand name or group [1, 2].

Resins are increasingly becoming the material of choice for dental restorations. Patient demand for esthetic restorations will ensure that this trend will continue. As a result there are currently over fifty resin brands on the U.S.market. Fortunately, the manufacturers vary their composition. Resins consist of several components, the principal of which are an organic matrix and inorganic filler particles. It is these filler particles that are resistant to heat and enable detection of resin brand, as the inorganic component will remain virtually unchanged even after being exposed to cremation conditions. This presentation describes the generation of a database of restorative resins that contains information about the unique properties of these materials.

For database generation, resins were prepared in 1cm discs and cured according to manufacturers' instructions. The discs were analyzed by scanning electron microscope (SEM), energy dispersive X-Ray spectroscopy (EDS), and X-Ray fluorescence (XRF). The discs were then placed in a burnout oven and exposed to a temperature of 900C for 30 minutes and the analysis was subsequently repeated.

The SEM produces images of high resolution, allowing detailed documentation of the resin microstructure. EDS analysis is performed concurrently in the SEM and an X-Ray spectrum is produced which represents an elemental fingerprint of the inorganic component within a sample. XRF is a separate analytical technique that similarly produces an elemental fingerprint. There are several distinct advantages in XRF over EDS in that the units can be portable, allowing them to be brought directly to the field.

The XRF can also detect trace amounts of an element, in the part per million ranges, and the spectrum is collected in a much quicker time, usually 6-10 seconds. The main disadvantage is that these portable units cannot detect elements lighter than phosphorus in the periodic table. In this database, both XRF and EDS spectra are presented, encompassing analysis by both methods.

The data produced by these methods was organized in database format utilizing software commissioned by the FBI[3]. The software is named Spectral Library Identification and Classification Explorer (SLICE). The database is maintained by the FBI and is thus available to the forensic community and can be queried as necessary.

When traditional methods of identification cannot be performed or show inconclusive results, then any alternative means can be of great importance. The ability to distinguish between resin brands or groups can add another level of certainty under these conditions. Under difficult circumstances the odontologist should be aware of the resources that are available.

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Knowledge that these analyses are possible and the baseline data provided here may aid in resolution when no other means is possible.

References:

1. Bush MA, Bush PJ, Miller RG. Detection and classification of composite resins in incinerated teeth for forensic purposes. J Forensic Sci 2006;51(3). 636-42.
2. Bush MA, Miller RG, Prutsman-Pfeiffer J, Bush PJ. Identification through XRF analysis of dental restorative resin materials: A comprehensive study of non-cremated, cremated, and processed cremated individuals. J Forensic Sci in press, January 2007.
3. Ward DC. Use of an X-Ray spectral database in forensic science. Forensic Science Comm. 2000;2(3)

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