G19 Complex Dental Restorative Techniques: Are They Recognizable and Do They Survive Extreme Conditions?

Alistair Soon, BDS, Forensic and Scientific Services, Forensic Odontology/Pathology Unit, 39 Kessels Road, Coopers Plains, Queensland 4108, AUSTRALIA; Mary A. Bush, DDS, SUNY at Buffalo, B1 Squire Hall, 3435 Main Street, Buffalo, NY 14214; and Peter J. Bush, BS, SUNY at Buffalo, South Campus Instrument Center, B1 Squire Hall, S Campus, Buffalo, NY 14214*

After attending this presentation, attendees will better understand how complex dental restorations withstand extreme conditions and how this knowledge may aid in routine dental identification or in Disaster Victim Identification (DVI).

This presentation will impact the forensic science community by providing the forensic odontologist with chemical and structural information of restorative materials and their interaction at high temperatures.

Recent research has shown that restorative dental materials can be recognized by microscopy and elemental analysis (Scanning Electron Microscopy/Energy Dispersive X-Ray Spectroscopy (SEM/EDS) and X-Ray Fluorescence (XRF)) and that this is possible even in extreme conditions such as cremation. These analytical methods and databases of dental materials properties have proven useful in DVI of a commercial plane crash in 2009 and in a number of other victim identification cases.

Dental materials appear on the market with ever-expanding frequency. With their advent, newer methods of restoration have been proposed and adopted in the dental office. Methods might include placing multiple layers of materials having different properties including adhesion, viscosity, working time, or curing methods. Use of different materials such as filled adhesives, flowable resins, glass ionomer cements, composite resins, liners and sealants is current.

In the normal process of forensic dental identification, restorations that exactly replicate tooth structure and color complicate the task for the forensic odontologist. With possible combinations of different materials in these restorations, the forensic odontologist is now confronted with a new difficulty: how to recognize each individual material. The question might be posed if it is even possible to perform this task.

Furthermore, an odontologist might be called upon to identify a victim under difficult circumstances, such as when presented with fragmented or incinerated remains. In these circumstances, the ability to identify specific dental materials could assist in the identification of the deceased.

Key to use of this information is whether these new materials and methods are detailed in the dental chart. Visual or radiographic inspection may not reveal the presence of a restoration, let alone the possible complex nature of that restoration.

Materials and Methods: Extracted teeth obtained from the State University of New York (SUNY) at Buffalo School of Dental Medicine were utilized in this *in vitro* study. Class II preparations in posterior teeth and Class IV preparations in anterior teeth were made. Restorations were completed using both single materials and materials in various combinations. The restorative materials used were the following: Composite resins (Grandio SO, Grandio Heavy Flow, Tetric EvoFlow, Tetric EvoCeram), glass ionomer cement (Fuji IX), and calcium hydroxide liner (Ultra Blend plus). Combinations of materials placed included Gradio Flo and Grandio SO, Fuji IX and Tetric EvoCeram, Tetric Flow and Grandio SO, and Ultrablend Plus and Tetric EvoCeram. Control samples of all dental materials were made in a ring mold. Cross-section fractured surfaces were analyzed by SEM/EDS. Elemental composition and microstructure of each material was recorded. Prepared teeth were then incinerated at 900°C for 30 minutes. As expected, these conditions caused separation of enamel from dentin and variable adhesion to, or separation of, dental materials to tooth structure. Resulting fragmented specimens were inspected by stereomicroscopy and analyzed by SEM/EDS.

Results: Post-incineration, dental restorations could be distinguished from burnt tooth structure by optical microscopy; however, it was not possible to differentiate one material from another by this means. With SEM/EDS, it was possible to differentiate the different dental materials in restorations using a combination of backscattered electron imaging and EDS analysis. Post-incineration elemental compositions matched those of pre-incinerated controls.

Conclusions: Complex dental restorations can survive incineration conditions. Each material retains its individual elemental properties, and is easily distinguishable using SEM/EDS. In everyday dentistry, dental restorations are becoming more complex, especially as dentists are now utilizing different dental materials to achieve "perfect" dental restorations. This presentation is to alert forensic odontologists to these challenges and to transfer awareness to general dentists to maintain accurate dental records, as each dental material used during dental restoration could be important in the outcome of dental identification.

Forensic Odontology, Disaster Victim Identification, Dental Identification