G23 The Use of Raman Spectroscopic Imaging in Cases of Ethylene Glycol Toxicity

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After attending this presentation, attendees will have reviewed ethylene glycol toxicity, the pathophysiology and histology of ethylene glycol poisoning, and be introduced to the concept of Raman imaging and how it can be used to identify calcium oxalate crystals in tissues.

This presentation will impact the forensic science community by introducing a new method to identify crystalline deposits in the kidneys when ethylene glycol is suspected.

The American Association of Poison Control Centers reported 6,077 exposures to ethylene glycol in the United States, resulting in 40 deaths in 2002. The State of Maryland had 15 cases of ethylene glycol intoxication from 1996-2009. Ethylene glycol is a colorless, odorless liquid which is the principal component of antifreeze. The toxic dose varies but more than 0.1 ml/kg body weight is the reported toxic dose requiring medical treatment. The primary symptoms are CNS depression followed by a cardiopulmonary stage with eventual renal failure. The lethal dose is approximately 100 ml in an adult. It is metabolized to oxalic acid which binds the calcium in the body forming calcium oxalate crystals that eventually lead to the renal failure. In addition, it does not show up on toxicologic analysis in a routine volatile screen.

Forensic pathologists may be presented with a death without an obvious cause, but crystals may be seen in the kidneys that suggest ethylene glycol poisoning with initial negative toxicology. Four cases involving probable ethylene glycol ingestion and the use of Raman imaging to identify calcium oxalate crystals are presented. The cases presented include three cases of known ethylene glycol toxicity and one case of suspected ethylene glycol toxicity with negative ethylene glycol and glycolic acid blood analyses and crystals in the kidneys.

The case that prompted the use of Raman imaging was that of a 52- year-old black male found deceased with vomitus on a pillow next to him in his father's vacant home. The decedent had no known psychiatric or past medical history. At autopsy an anomalous right coronary artery and dull green stomach contents were found. Microscopic examination of the kidneys revealed multiple polarizable crystals consistent with calcium oxalate. This prompted additional police investigation revealing the subject was estranged from his family. No additional medical or social history was gained. Toxicologic analysis of blood for ethylene glycol and oxalic acid was negative. Raman imaging showed that the crystals were indeed calcium oxalate. The cause of death was anomalous right coronary artery complicated by oxalosis and the manner classified as Undetermined. Three other cases of known ethylene glycol toxicity underwent Raman imaging. In all cases, toxicologic analysis of the blood was positive for ethylene glycol, autopsy showed crystals in the kidneys, and the cause of death was ethylene glycol intoxication and manner was undetermined.

Raman molecular imaging is a method used to identify molecular structures. It is a physical phenomenon involving the interaction of light with molecules. This method is based on inelastic (Raman) scattering of monochromatic light from a source such as a visible laser, a near infrared laser, or near ultraviolet laser. The laser interacts with phonons in the system, resulting in the energy of the laser photons being shifted up or down. The shift in energy is then related as data concerning the phonons in the system being studied. The unstained aluminum slide is illuminated with a laser beam, light from this spot is collected with a lens, and then sent through a monochromator. Wavelengths similar to the laser are filtered out, and the rest of the light is collected into a detector. A given solid material has characteristic phonon modes that can help to identify it.

Raman molecular imaging was able to characterize the unknown crystals as calcium oxalate in all four cases of suspected ethylene glycol toxicity. The confirmation of the calcium oxalate crystals in the kidneys in the case with negative blood ethylene glycol and oxalic acid was helpful. In this case, the inability of investigation to establish clear social and medical history or the source of the oxalosis left the possibility of primary or secondary hyperoxaluria or an exogenous ingestion. Therefore, the manner was best certified as Undetermined.

This case series demonstrates the utility of Raman imaging to confirm the presence of calcium oxalate crystals in the kidneys. The correlation of these crystals to ethylene glycol intoxication requires complete toxicologic analysis and thorough investigation. Raman imaging could have many broad applications in the forensic pathology community and to the forensic community in general in the identification of unknown substances in tissues of all types. **Raman Imaging, Ethylene Glycol, Calcium Oxalate**

 ** Presenting Author*