Magnetic Resonance Spectroscopy (MRS) for Postmortem Forensic Investigations

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At our institute, we are exploring the power of **Magnetic Resonance Spectroscopy (MRS)** for postmortem forensic investigations. Using our 3-Tesla MR scanner, we examine deceased individuals non-invasively.

Our research to date has focused on four key areas:

1. **Unmasking Metabolic Imbalances:** MRS allows us to detect and quantify metabolites like glucose, acetone, and β-hydroxybutyrate in the brain, whose elevated levels indicate metabolic imbalances. We have developed and validated a method on 20 individuals, comparing MRS results from with biochemical analyses to diagnose potential metabolic causes of death.

2. **Quantifying Brain Ethanol:** The consumption of alcoholic beverages leads to an ethanol concentration in the brain, which can be detected using MRS. In a study of 15 deceased, we measured ethanol levels in the cerebrospinal fluid of the left lateral ventricle and validated our method by comparing it with biochemical blood analyses.

3. **Non-invasive Temperature Measurement of Brain Tissue:** The temperature-dependent shift of the water peak in the spectrum allows the estimation of tissue temperatures. By identifying a suitable reference metabolite, we have adapted this method for postmortem applications. The adapted method was validated in an animal model and in 82 deceased individuals.

4. **Determination of Brain pH Using MRS:** We utilize the pH-dependent shift of acetate to estimate pH non-invasively. This approach, validated on 23 individuals by comparing MRS-based values with conventional pH measurements, opens doors to study the conditions that lead to very low postmortem brain pH.

Postmortem MRS empowers us to:

- **Diagnose and quantify metabolic causes of death**
- **Study the concentration and distribution of ethanol in the brain**
- **Non-invasively determine tissue temperatures and pH values**

Moreover, MRS-derived parameters like tissue temperature and pH value show promise for utilization in postmortem MRI, assisting radiologists and forensic pathologists in discerning postmortem changes from pathological and trauma-related findings.