Spatial Metabolomics by Mass Spectrometry Imaging using Desorption Electrospray Ionization (DESI)

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INTRODUCTION

- Spatial mapping of metabolites can increase our understanding of the biological functions of those molecules within the tissue
- Mass spectrometry imaging, such as Desorption Electrospray Ionization (DESI), can be used to map the distribution of molecules from any flat surfaces, including tissue sections without much sample preparation
- Mass spectrometry imaging using DESI have been developed to image metabolites directly off tissue sections, such as rodent brain
- Examples of metabolites detected included amino acids (e.g., taurine, glutamine, arachidonic acid), neurotransmitters (e.g., GABA, serotonin) along with lipids (e.g., phosphatidylcholine, lysophosphatidylcholine)
- This preliminary work indicated the utility of DESI imaging for clearly distinguishing localized metabolites and lipids to provide insights for spatial metabolomics research.

METHODS

- **Tissue.** Rat brain was harvested and flash-frozen in liquid nitrogen before cryosectioning. Tissue sections were mounted on a glass microscope slides, vacuum dried, and analyzed without any other sample preparation.
- **DESI Mass Spectrometer.** DESI imaging platform was coupled with a quadrupole time-of-flight mass spectrometer (SYNAPT G2-XS or Xevo G2-XS) was used for the imaging data acquisition.
- **Data Processing Platform.** Molecular maps were processed by High Definition Imaging (HDI) and overlaid with an optical image of the tissue to co-register the molecular distribution based on the anatomical features of the brain, such as the corpus callosum. Spatial correlation between detected metabolites and lipids were explored using analysis based on Pearson product-moment correlation coefficient in HDI software.
- **Molecular Annotation.** Molecular identification was aided using high mass accuracy database searches against curated databases, e.g., Human Metabolome (HMDB)

DESI MS IMAGING CONDITIONS

- Mass Spectrometer: Xevo G2-XS Quadrupole Time of flight (Q-ToF)
- Acquisition range: 50-2000 Daltons
- Acquisition mode: MS in resolution mode
- DESI solvent: 98% Methanol and 2% Water with 0.1% formic acid

RESULTS & DISCUSSIONS

- DESI mass spectrometer imaging excels at detecting and mapping several molecules simultaneously and directly from tissues such as rodent brain
- DESI is capable of producing molecular images with a high spatial resolution at a few hundreds microns pixel size, here DESI images were acquired with 40 μm pixel sizes
- Several metabolites such as taurine, glutamine, arachidonic acid, GABA, serotonin, phosphatidylcholine lipids, lysophosphatidylcholine lipids can be visualized with high specificity and sensitivity

REFERENCES