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Abstract Search

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QUANTIFYING METAL DISTRIBUTIONS USING SYNCHROTRON X-RAY FLUORESCENCE IMAGING OF NEOCORTEX RESECTED IN HUMAN EPILEPSY SURGERY

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Content:

RATIONALE:
Metals have been shown to elicit seizures in several experimental models of epilepsy and have been implicated in clinical conditions. Although metals have many essential roles in healthy brain function, their precise connection to epilepsy is not well understood. The study of the relation between metals and epilepsy has been limited, in part, by challenges in quantifying the levels of multiple brain metals, while also ascertaining their spatial distribution. Here we show that synchrotron X-ray fluorescence imaging (SXRF) can be used to reveal information about multiple metal co-localization in human resected brain tissue.
METHODS:
Resected cortical tissue from surgical cases of patients (n=12) with intractable mesial temporal lobe epilepsy (MTLE) were imaged using rapid-scanning SXRF and microprobe imaging (beamlines 10-2 and 2-3) at the Stanford Synchrotron Radiation Lightsource. Nissl stained and unstained tissues were compared for gross and microscale differences in endogenous metals. Fluorescence maps of metals previously implicated in epileptogenesis (e.g., Fe, Zn, Ca, Cu, Mn) were generated by windowing the K- or L- edges of these elements. However, the complete spectra were also captured for later analysis of additional metals. Images were analyzed using Sam's Microprobe Toolkit.
RESULTS:
Using SXRF imaging we were able to co-localize and quantify multiple metals in sequential cross sections. This included the co-localized imaging of Fe, Zn, Ca, Cu, Mn at resolutions as high as 1μm. The resected tissue showed large variability in metal distribution both between subjects and within the local cortical area. Results also showed that Nissl staining affected the levels of some metals (e.g., Cu, S, K) more than others (e.g., Fe, Zn).
CONCLUSIONS:
Our study demonstrates the surveying ability of SXRF to detect low but biologically significant levels of endogenous metals. Although increases in sample size will help determine if multiple metal-based subgroups of epilepsies exist, the method has allowed for the first quantification of multiple metals at high resolutions in the human epileptic brain. Imaging distribution and co-localization of metals in the brain may be critical for identifying mechanisms of epileptogenesis in certain types of intractable epilepsy as well as identifying novel therapeutic approaches.

Back to search results