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XFM mapping of elemental distributions in brain stem sections from multiple sclerosis patients using the BioMaia detector

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Locus ceruleus (LC) neurons supply central nervous system cells with noradrenaline, and damage to the LC has been found in multiple sclerosis (MS) and in neurodegenerative diseases such as Alzheimer's disease. LC neurons selectively accumulate heavy metal toxicants, which could play an important role in the pathogenesis of these diseases. Histochemical studies of brain tissue from MS patients suggest Hg as a potential toxin in the LC, but there may be other metal toxicants present in the LC that cannot be detected histochemically. We therefore used the X-ray Fluorescence Microscopy (XFM) Beamline at the Australian Synchrotron to image the LC in cryo-fixed brain stem sections of MS patients. The 384-element BioMaia detector provided the elemental sensitivity required to map the metal toxicants of interest (such as Hg, Pb, and Cr), as well as lighter elements such as S and Se, whose co-localization with the heavy metals can provide further evidence for the physiological effects of these metals. The spatial resolution of BioMaia (smaller than 1 μm) is also important in identifying toxicants in glial cells (such as oligodendrocytes, average diameter 10 μm), which are smaller than the LC neurons (average diameter 40 μm). We show that in MS (1) a number of different metal toxicants can be found in LC neurons, and (2) glial cells may also contain metal toxicants.

Keywords

x-ray fluorescence, neurodegenerative diseases, heavy metals, locus ceruleus neurons

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