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Commentary

Application of Mass Spectrometry Imaging Technology Represents a Breakthrough in Drug Toxicity

Wu Lian*

Department of Toxicology, University of Freiburg, Breisgau, Germany

DESCRIPTION

By simultaneously detecting and mapping endogenous or exogenous molecules in biological tissue slices without specific chemical labelling or difficult sample pretreatment, Mass Spectrometry Imaging (MSI), a potent molecular imaging technology, can obtain qualitative, quantitative, and location information. In this article, the evolution of MSI and its application to drug toxicity science are discussed, including the tissue distribution of toxic drugs and their metabolites, the target organs of toxic drugs (liver, kidney, lung, eye, and central nervous system), the identification of toxicity-associated biomarkers, and an explanation of the mechanisms of drug toxicity when MSI is combined with cutting-edge omics methodologies. This technology's distinctive benefits and wide-ranging potential have been amply established to support the expansion of its application in the study of pharmaceutical toxicity.

When thinking about employing a medicine to treat a condition, safety and effectiveness are two elements of the drug's features to consider. When using medications to treat illnesses, one must take into account the toxicity and side effects of the medications. Drug toxicity testing, thus, can dramatically lower toxicity and side effects, lower research expenditure, shorten the development cycle, and increase the success rate of the listing. Drug toxicity studies can also offer pertinent information and lay the groundwork for sensible clinical drug usage, decreasing patient toxicity and adverse effects following prescription delivery. The precise distribution and quantitative detection of drugs and their metabolites in tissues are useful in drug toxicology investigation to ascertain pharmacokinetic parameters, pinpoint the distribution and accumulation of drugs in organs, and investigate the effects of drugs on the body and their potential toxicological mechanisms. Drug action mechanisms and associated targets are a part of toxicological mechanisms. By analyzing the body's metabolites, lipids, and proteins before and after treatment, researchers can find biomarkers for drug toxicity, forecast its effects, and assess its toxicity. Currently, Liquid Chromatography-Mass Spectrometry (LC-MS) analysis, fluorescent labelling, and immunohistochemistry are the principal techniques for the qualitative and quantitative identification of drug distribution patterns. Although LC-MS has high sensitivity, in situ information cannot be retained, and immunohistochemistry is highly specific, it can only measure the biodistribution of a single target for which antibodies are available. QWBA and fluorescence labelling, on the other hand, are unable to distinguish the parent drug from its metabolites. Because it can concurrently conduct qualitative, quantitative, and positioning tasks, emerging Mass Spectrometry Imaging (MSI) technology can get over the aforementioned restrictions and offer relative abundance information of substances based on in situ spatial information. Without radionuclides or fluorescent markers, MSI can carry out high-throughput detection and imaging of both known and unidentified compounds concurrently. Additionally, MSI has a quick experimental duration, a wide scan range, high sensitivity, high specificity, and high spatial resolution. Botany, microbiology, food chemistry, medicine, pharmacy, and other areas have all made extensive use of this technique. The present article summarises the various uses and future directions of MSI in the field of drug toxicology, illustrates its application for qualitative and quantitative detection of drug and metabolite distribution in organ toxicity studies, and supports the emerging function of MSI in conjunction with omics technology in fostering the identification of toxic biomarkers and insights into toxicological mechanisms.

Correspondence to: Wu Lian, Department of Toxicology, University of Freiburg, Breisgau, Germany, E-mail: lianw@uhrc.de

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