Screening Malignant Glioma Using an Electrical Differential Impedance Spectrometer and Artificial Neural Network

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In the United States, 23,830 new primary malignant tumors of the brain and central nervous system (CNS) are expected to be diagnosed in 2018, according to the Central Brain Tumor Registry of the US. A 2013 study cited 73.8% of malignant brain tumors were glioma. Early detection of malignant glioma is crucial for more effective medical and surgical management. Medical imaging techniques, such as CT and MRI, are used for diagnosis. However, limited by the availability of CT or MRI and the nonspecific presenting symptoms, such as headaches, many malignant glioma are diagnosed rather late. This work applied ten frequencies of electrical signals measuring brain tissue impedance of patients with and without malignant glioma. The clinical data was analyzed using a multi-layered artificial neural network. This work discovered that malignant glioma strongly correlates with the differential impedance of brain tissue. This study showed sensitivity and specificity from 80% to 90%, depending on the training results of the neural network. This work demonstrates the superior ability of artificial intelligence to recognize the pattern in a large set of data which cannot be described readily by mathematical equations. The complex information embedded in the magnitude and phase of the differential impedance at the ten different frequencies can be recognized by an artificial neural network with proper training. A portable spectrometer device for such measurements can be made at low cost, which can be used as an effective screening modality for early detection of malignant glioma with nonspecific presenting symptoms.

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