Raman spectroscopy for glioblastoma

Recently, newer techniques have emerged and are being translated into the operating room, promising delineation of glioblastoma tissue using targeted approaches or identification on a microscopic level, for instance using Raman spectroscopy or confocal microscopy [1)].

Detailed analysis of breast ductal carcinoma in situ, and astrocytoma brain tissues as well as cells of glioblastoma U87 MG showed that Raman scattering generates images as accurately as histology hematoxylin and eosin stain used in clinical practice with additional advantage of biochemical information. Combination of AFM maps and Raman images allows to correlate mechanical properties with biochemical composition of cells [2)].

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Vital and necrotic glioblastoma tissues were studied by Raman microspectroscopy to identify possibilities for the development of an in vivo Raman method for real-time intraoperative brain biopsy guidance. The histologic malignancy grade of gliomas depends on the presence of parameters such as endothelial proliferation and necrosis, which are often not evenly distributed within the tumor. Because tissue samples obtained by stereotactic surgery are relatively small, sampling errors may easily occur by missing these crucial features. Although necrosis is important for grading, specimens containing only necrosis are diagnostically useless. Raman microspectroscopic mapping experiments were performed on unfixed cryosections of glioblastoma, obtained from 20 patients. After spectral acquisition, a clustering analysis was performed, resulting in groups of similar spectra. Each cluster was assigned a color, and pseudo-color Raman maps of the tissue sections were constructed. After the Raman experiments, the tissue sections were stained for histopathologic analysis, enabling identification of the histologic origin of the Raman spectra and assignment of the Raman spectral clusters to either vital or necrotic tissue. A classification model for discrimination between vital and necrotic tumor tissue based on linear discriminant analysis was developed. The classification model was evaluated using independent Raman data obtained from nine other tissue sections and yielded 100% accuracy. Information about the biochemical differences between necrosis and vital tumor was obtained by the analysis of difference spectra. Necrotic tissue was found to consistently contain higher levels of cholesterol (-esters). This in vitro result indicates that Raman spectra contain the information to distinguish vital glioblastoma from necrosis and makes Raman spectroscopy a powerful candidate for guidance of stereotactic brain biopsy. [3)]

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