Raman spectroscopic analysis of nonalcoholic fatty liver disease (NAFLD) in rats

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Nonalcoholic fatty liver disease (NAFLD) is classified into the two categories of nonalcoholic fatty liver (NAFL) and nonalcoholic steatohepatitis (NASH). NAFL may progress to NASH with fibrosis for which prognosis is not very good. However, it is difficult to predict future fibrosis histologically. Fibrosis mainly occurs by activation of stellate cells containing rich vitamin A. Raman spectroscopy is a technique that can analyze information on molecular species and structure without labels. There is a possibility of sensitive detection of vitamin A and lipid, which may be indicators of activation of stellate cells and steatosis detected by Raman spectroscopy. In this study, we investigated whether Raman spectroscopic analysis is useful for predicting fibrosis in rat NAFLD.

Methods: Three groups of rats were fed a standard diet, a high fat diet (HFD), and a high fat, high cholesterol diet (HFHC) for 2 to 16 weeks, and liver tissues were collected and subjected to histological and Raman spectroscopic analyses.

Results: Liver histology was normal in the HFD group, and NAFL was found in the HFHC group at 2 weeks after feeding. At 16 weeks after feeding, NAFL was found in the HFD group and NASH with fibrosis in the HFHC group. Raman spectra showed enhanced lipid peaks and attenuation of vitamin A peaks in the HFHC group. Although the HFHC group after 2 weeks and the HFD group after 16 weeks showed similar histology of NAFL, the Raman intensity ratio of lipids to vitamin A could distinguish them and identified the very early state of NASH.

Conclusion: Raman spectroscopy could sensitively capture the signatures of fat and vitamin A in rat livers, suggesting the possibility of predicting the progression of fibrosis in NAFLD.