

Prognosis Prediction of Glomerulonephritis Using Wax-Physisorption-Kinetics-based FTIR Imaging and Kinetic ATR-FTIR

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Abstract

Systemic lupus erythematosus (SLE) is a complex and potentially enduring autoimmune disease characterized by the production of autoantibodies to self-antigens and deposition of immune complexes in multiple organs. Importantly, lupus nephritis (LN) is a common and severe organ involvement in SLE patients, especially in Asia-Pacific regions. Moreover, renal survival is much poorer in childhood-onset LN than adolescent-onset LN. This is probably because that renal injury is initiated at the early beginning in the pediatric patients diagnosed of SLE. Profiling aberrant population of long-chain glycans residue of glycoprotein distributing in the very early stage of malignancy has been successfully demonstrated using wax-physisorption-kinetics-based Fourier transform infrared spectroscopic (WPK-FTIR) imaging [1-3]. The strength of van der Waals interaction is strongly correlated with the amount of wax residue between glycans of glycoprotein adhering onto biomedical sample surface and the given carbon number (CN) n-alkane employed as the glycan adsorbent. Malignant cells/ tissue showed a stronger physisorption with higher CN n-alkanes; however, weaker physisorption with higher CN n-alkanes residue was found within the non-malignant samples. Similarly, higher population of aberrant glycan structure of glycoprotein induced by autoimmune reaction was observed in Systemic lupus erythematosus (SLE) pediatric patients with lupus nephritis (LN), showing a more amount of n-octacosane residue on the tissue section surface of inflammatory glomeruli than that of n-docosane. Oppositely, normal glomeruli had lower population of long-chain glycans of glycoprotein, demonstrating weaker physisorption with n-octacosane adsorbent than that with n-docosane. Accordingly, a higher ratio of absorption of n-octacosane residue to that of n-docosane residue ($A_{n\text{-octacosaneR}}/A_{n\text{-docosaneR}}$) in spectral range of 3000-2800 cm^{-1} is observed for inflammatory glomerulonephritis. In present study, serial serum collections from the patients with childhood LN were measured their hydrophobic index (HPI), the ratio of the peak height of absorption band of $\nu_{\text{as}}(\text{CH}_2)$ at 2929 cm^{-1} to that of $\nu_{\text{as}}(\text{CH}_3)$ at 2960 cm^{-1} , by using ATR-FTIR. As a result, higher HPI was observed in dried serum samples of LN patients compared with the healthy. Furthermore, increasing peak height ratio of absorption band of $\delta(\text{CH}_2)$ at 1457 cm^{-1} to that of $\delta(\text{CH}_3)$ at 1400 cm^{-1} was also relevant in LN patients, and which $\delta(\text{CH}_3)$ band would be attributed mainly from the serum albumin due to renal inflammation [4, 5]. The preliminary results reveal that the higher HPI value (>1) was marked in the beginnings of immunosuppressive treatment in LN, whereas the lowered HPI value was observed while the remission of LN patients after effective treatment. Conclusively, the spectral marker package included kidney $A_{n\text{-octacosaneR}}/A_{n\text{-docosaneR}}$ ratio and HPI and/or serum $\delta(\text{CH}_2)/\delta(\text{CH}_3)$ ratio is of great potential to become an emerging diagnostic methods of prognosis prediction of LN and/or therapeutic surveillance of SLE.

Keywords – Systemic Lupus Erythematosus, Lupus nephritis, Wax physisorption kinetics, Hydrophobic index

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