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LETTER TO THE EDITOR

On the nature of toenail opacities in renal insufficiency

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To the Editor

Soma et al. recently reported on big toenail opacities as a predictor of poor prognosis in patients with end-stage renal disease on hemodialysis [1]. This interesting clinical observation deserves attention. It should be noted that human nails almost exclusively consist of keratins, which are specialized proteins. Furthermore, nails are in close contact with the capillary bed of the toe. As nail growth is a slow process (on average the migration takes 9 months from proximal to distal), chemical reactions occur between small molecular mass compounds (e.g., glucose, urea) and the nail keratins [2, 3]. These processes (glycation, carbamoylation) affect the protein structure and function, which eventually may lead to macroscopic changes of the nail structure. Therefore, it is of utmost importance to elucidate the chemical nature of toenail opacities. We, therefore, analyzed toenails from hemodialysis patients and healthy subjects using near-infrared (NIR) spectrometry. An NIR spectrometer equipped with an immobilized reflection probe (AvaSpecNIR256-2.5-HSC with a FCR7UVIR400-2-BX reflection probe, Avantes) was used. The spectra were computed across the spectral range 2500−950 nm, followed by spectral data analysis which was performed using SIMCA version 15.0 (Umetrics, Umeå, Sweden). Figure 1 compares the NIR spectra toenails of healthy controls ($n = 10$), patients with terminal renal insufficiency treated with hemodialysis ($n = 10$) and two patients on hemodialysis presenting with opacified toenails. In the patients presenting with opacified toenails, marked spectral differences were observed in the second derivative at wavenumber ranges 1200 nm (corresponding to the second overtone band of CH_3 bonds), 1650 nm (the first overtone of CH_3 bonds), and 2150 and 2220 nm (CH_3 bonds) [4]. The additional spectral bands observed in the NIR spectra of opacified toenails are due to the chemical modification of nail keratin structure. In conclusion, the observed macroscopic changes in hemodialysis patients with opacified toenails can be associated with keratin modification. In a large prospective study with hemodialysis patients, we will investigate the kinetics of the opacification process of toenails using NIR microscopy analysis every 6 months and correlate these

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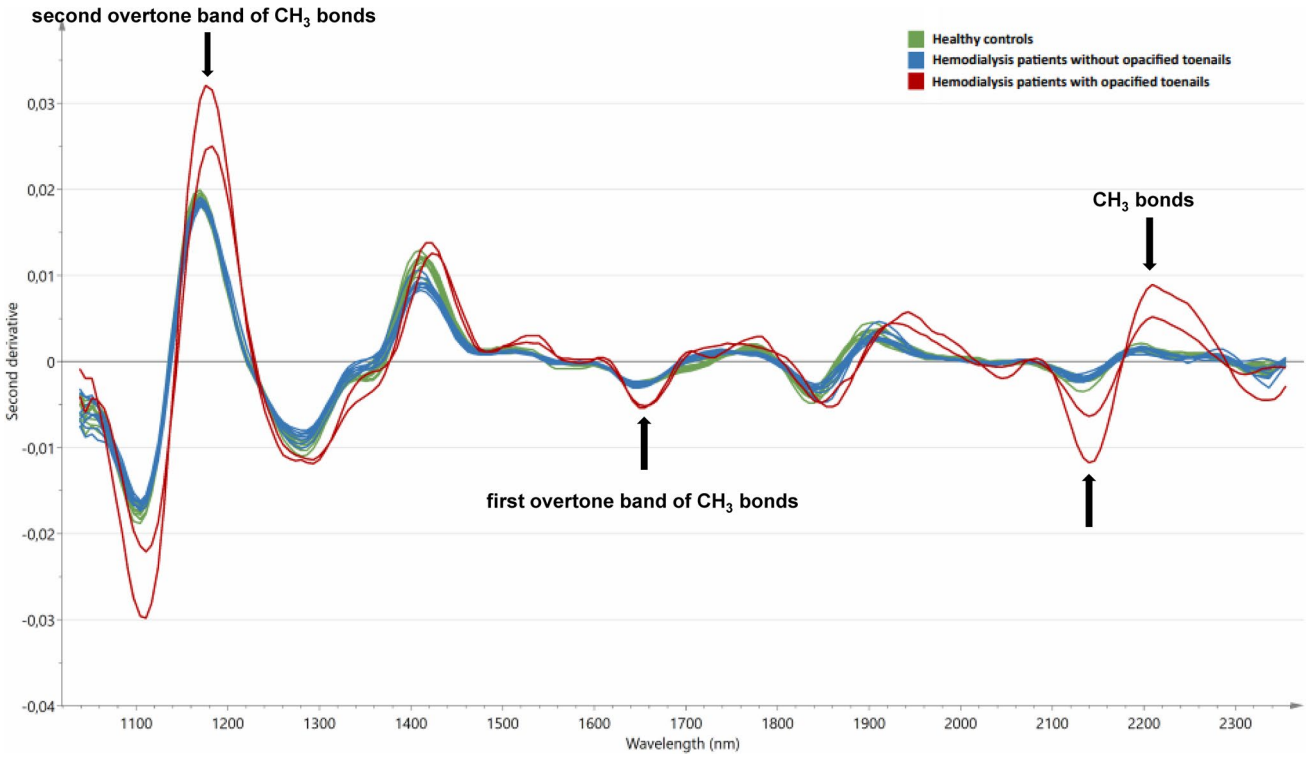

Fig. 1 Near-infrared spectrum of non-opacified toenails of healthy subjects (green, $n=50$), non-opacified toenails of hemodialysis patients (blue, $n=50$) and opacified toenails of hemodialysis patients (red, $n=2$). The arrows mark the specific spectral changes observed in opacified toenails

findings with the concentration of uremic toxins, dialysis efficiency, cardiovascular morbidity and all-cause mortality.

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