Narrow-band Ultraviolet B Exposures Improve Vitamin D Balance – Trials Involving Dermatological and Haemodialysis Patients and Healthy Subjects

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Meri Ala-Houhala defended her PhD thesis on November 22, 2013 at the University of Tampere. Her main supervisors were Professor, emeritus Timo Reunala, University of Tampere and Professor Erna Snellman, University of Tampere, Tampere, Finland. The Opponent was Associate Professor Leena Koulu, University of Turku, Turku Finland. The thesis is available at http://urn.fi/URN:ISBN:978-951-44-9261-7.

Narrow-band ultraviolet B (NB-UVB) phototherapy is used to treat dermatological diseases such as psoriasis and atopic dermatitis. Some previous studies have suggested that it also increases serum 25-hydroxyvitamin D (25(OH)D) concentrations. On the other hand, most patients with chronic kidney disease (CKD) requiring dialysis are known to have insufficient vitamin D. We therefore conducted trials to assess how short NB-UVB courses could affect serum 25(OH)D concentrations in dermatological and haemodialysis patients in winter, when little UVB from the sun is available for vitamin D synthesis. In addition, we compared the effects of an NB-UVB course and oral vitamin D supplementation on serum 25(OH)D concentrations in healthy subjects.

In the first trial (I), 89% of the patients with psoriasis, 94% of those with atopic dermatitis and 53% of the healthy subjects were found to have baseline vitamin D insufficiency (serum 25(OH)D <50 nmol/l). A course of 15 whole body NB-UVB exposures significantly increased serum 25(OH)D ($p < 0.001$), by 59.9 nmol/l in the psoriasis patients, 68.2 nmol/l in the atopic dermatitis patients and 90.7 nmol/l in the healthy subjects. PASI (Psoriasis Area and Severity Index) and SCORAD (Severity sCORing of Atopic Dermatitis) improved significantly ($p < 0.001$), but no correlation with the increase in serum 25(OH)D was found. Expression of antimicrobial peptides (AMPs), cathelicidin and human beta-defensin 2 (HBD2) was high in the psoriasis skin lesions. After 6 NB-UVB treatments cathelicidin had increased further, while HBD2 expression had decreased. NB-UVB caused a marked but non-significant decrease in the cytokines interleukin (IL)-1beta and IL-17 in the psoriasis lesions. It was concluded that, in addition to a significant improvement of psoriasis and atopic dermatitis, NB-UVB treatment effectively corrects vitamin D insufficiency. It also increases cathelicidin and lowers HBD2 levels in healing psoriasis and atopic dermatitis skin lesions. This effect may be mediated by the improved vitamin D balance and the local cytokine network.

Fig. 1. Meri Ala-Houhala defended her PhD thesis on vitamin D balance and narrow-band ultraviolet B exposure in Tampere in November 2013. Associate Professor Leena Koulu was the Opponent (right) and Professor Erna Snellman acted as Custos and Supervisor (middle).

In the second trial (II) healthy adult hospital employees and medical students having serum 25(OH)D below 75 nmol/l were randomly given either a course of 12 whole body NB-UVB exposures or 20 µg of oral cholecalciferol daily for 4 weeks. The baseline serum 25(OH)D concentrations were similar in both groups: 52.9 nmol/l in the 33 NB-UVB-treated subjects and 53.5 nmol/l in the 30 treated with oral cholecalciferol. The mean increase in serum 25(OH)D was 41.0 nmol/l in the NB-UVB group and 20.2 nmol/l in the cholecalciferol group, the difference being significant at 2 weeks ($p = 0.033$) and at 4 weeks ($p < 0.001$). Two months after treatments the 25(OH)D concentrations had decreased in both groups but were still clearly higher than the baseline values. It was concluded that 12 NB-UVB exposures given over 4 weeks increase the serum 25(OH)D concentration significantly more than do daily doses of 20 µg oral cholecalciferol. A short, low-dose NB-UVB course is therefore an effective way of improving the vitamin D balance in winter, and the response is still evident 2 months after the course.

In the third trial (III) 15 haemodialysis patients and 12 healthy subjects received 9 upper body NB-UVB exposures. Mean serum 25(OH)D levels before NB-UVB were 32.5 nmol/l in the dialysis patients and 60.2 nmol/l in the healthy subjects ($p<0.001$). After eight NB-UVB exposures serum 25(OH)D had increased by 13.8 nmol/l (43%; $p<0.001$) in the dialysis patients and 1,25-dihydroxyvitamin D (1,25(OH)2D) by 3.3 pmol/l (27%; $p = 0.002$). Serum 25(OH)D in the dialysis patients was still 10% higher two months after NB-UVB exposures than initially. The mRNA expression level of CYP27B1, an enzyme needed for the final hydroxylation of vitamin D to its active metabolite, was examined in skin biopsy specimens and was found to have increased after NB-UVB exposures relative to the level in non-treated healthy subjects ($p = 0.04$). It was concluded that a short course of NB-UVB exposures significantly increases serum 25(OH)D and 1,25(OH)2D in dialysis patients, but the effect is short-lasting suggesting that patients need cyclic NB-UVB exposures to maintain their improved vitamin D concentrations.

In the fourth trial (IV) 14 haemodialysis patients and 15 healthy subjects receiving oral cholecalciferol supplements of 20 µg daily were given 9 whole body NB-UVB exposures. Given baseline serum 25(OH)D concentrations of 57.6 nmol/l in the dialysis patients and 74.3 nmol/l in the healthy subjects the NB-UVB course increased serum 25(OH)D significantly ($p<0.001$), by 14.0 nmol/l in the former and 17.0 nmol/l in the latter. The dialysis patients showed significantly increased baseline CYP27B1 levels and decreased CYP27A1 levels in the skin relative to the healthy subjects. It was concluded that a short NB-UVB course is an efficient way of improving the vitamin D balance in dialysis patients who are receiving oral vitamin D supplementation. The increased cutaneous CYP27B1 levels in the dialysis patients suggest that the loss of the renal activity of this enzyme is at least partially compensated for in the skin.

To conclude, NB-UVB exposures were shown to be an efficient way of increasing the serum 25(OH)D concentration in dermatological and dialysis patients and in healthy subjects in winter. A short NB-UVB course was shown to increase serum 25(OH)D in healthy subjects significantly more than did daily supplementation with 20 µg oral cholecalciferol. NB-UVB courses offer a new possibility for improving the vitamin D balance in dialysis patients who have an insufficiency of this vitamin.