Heliotherapy and Narrow-band UVB Improve Vitamin D Balance

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Katja Vähävihu, MD defended her PhD thesis in Tampere (Tammerfors), on September 24th 2010. The thesis was supervised by Docent Erna Snellman and Professor Timo Reunala, Department of Dermatology, University of Tampere, and the Opponent was Professor Aarne Oikarinen from the Department of Dermatology, University of Oulu (Uleåborg), Finland. The thesis can be found at: http://acta.uta.fi/english/teos.php?id=11355.

At present,vitamin D insufficiency is common worldwide. In the Nordic countries and Britain this condition affects people especially during winter, when vitamin D synthesis induced by sunligt is zero. Solar ultraviolet (UV) exposure is crucial for vitamin D synthesis and as much as 90% of all requisite vitamin D is formed in the skin. The desirable concentration of serum calcidiol (25(OH)D, 25-hydroxyvitamin D), which is the best indicator of vitamin D status, is still under debate but a concentration of 50–80 nmol/l is considered to be optimal for the skeleton. Calcitriol (1,25(OH)D, 1,25-dihydroxyvitamin D), the active form of vitamin D produced in the liver and kidney, but also in other tissues, such as the skin or prostate, is considered to be an autocrine or paracrine hormone, which regulates various cellular functions including cell growth. Due to this, vitamin D insufficiency seems to have far more extensive consequences for health than previously thought, ranging from well-known bone disease to prostate and other cancers and even to autoimmune diseases.

The amount of UVB exposure needed to induce vitamin D synthesis has been poorly studied. The present studies aim to examine the effects of natural sunlight during heliotherapy and artificial narrow-band UVB (NB-UVB) on vitamin D balance in winter.

Heliotherapy has long been used in the treatment of psoriasis and atopic dermatitis (AD), but its effect on vitamin D balance has not been previously examined. In the first study (I) we examined serum calcidiol concentrations in 23 patients with AD during a two-week heliotherapy course in the Canary Islands. At onset, 74% of the AD patients had vitamin D insufficiency (serum calcidiol <50 nmol/l). The median personal UVB dose received in the January heliotherapy group was 60 standard erythema doses (SED) and in the March group 109 SED. Serum calcidiol increased significantly both in the January (13.4 nmol/l) and March (24.0 nmol/l) groups. The calcidiol level remained elevated for at least 1–2 months. Heliotherapy significantly improved SCORAD (severity scoring of atopic dermatitis), by 70% in both groups, but only in the March group was there clear correlation between the increase in serum calcidiol and the improvement of SCORAD.

Fig. 1. Katja Vähävihu (*middle*) from Tampere, Finland defended her PhD thesis on vitamin D and heliotherapy and narrowband UVB. The Supervisor of the thesis was Professor Timo Reunala (*right*) and the opponent was Professor Aarne Oikarinen from Oulu.

In the second study (II) we compared two methods, individual Bacillus subtilis spore film UV dosimeters and a Robertson Berger meter (RB meter) combined with personal diary records, in measurement of UVB doses received during a two-week heliotherapy course in the Canary Islands. The mean personal UVB dose measured in a total of 21 AD patients with dosimeters was 75 SED in the January and 131 SED in the March group. The results from the RB meter combined with diary records were 63 SED and 119 SED, respectively. Serum calcidiol concentration increased by 9.7 nmol/l in the January and by 26.0 nmol/l in the March group. The increase in serum calcidiol correlated significantly with the UVB dose received. The results of the personal dosimeters and the RB meter combined with diary records showed a strong concordance correlation (r=0.63), indicating that spore film dosimetry is a reliable and easy way to measure personal UVB doses during heliotherapy.

In the third study (III) we examined whether narrowband (NB)-UVB exposures, used widely in the treatment of psoriasis and AD and emitting UVB near the range of vitamin D synthesis (311–313 nm), improves vitamin D balance. Fifty-three healthy women received NB-UVB exposures either on

the whole body ($n = 19$), on the head and arms (n = 9) or on the abdomen ($n = 14$). The exposures were given on seven consecutive days. Similarly, seven solar simulator exposures were given on the face and arms ($n = 11$). The cumulative UVB dose was 13 standard erythemal units (SED) in all regimens. At onset 77% of the women suffered from vitamin D insufficiency and, in addition, six subjects from vitamin D deficiency (serum calcidiol < 25 nmol/l). Calcidiol concentration increased significantly in all study groups. When receiving NB-UVB exposures only on the head and arms, the increase in serum calcidiol was nearly the same as when the whole body was exposed, 11.0 nmol/l and 11.4 nmol/l, respectively. NB-UVB exposure on the abdomen increased calcidiol by 4.0 nmol/l and solar simulator exposures given on the face and arms by 3.8 nmol/l. The effect of NB-UVB exposures was long-lasting. After two months, serum calcidiol was still higher than initially in the group that was followed up, i.e. the group receiving NB-UVB exposures on the whole body.

In the fourth study (IV) we measured the changes in serum calcidiol after 6 (12.3 SED) and 15 (71.5 SED) NB-UVB treatments given during winter in 18 patients with psoriasis, 18 patients with AD and 15 healthy subjects. In addition, using skin biopsies we studied the effects of exposures on antimicrobial peptides, cytokines and chemokines by PCR techniques. The NB-UVB exposures were given three times a week for a total of 15 times on the whole body. Skin biopsies were taken before the treatment and after six exposures. Before treatment 89 % of the patients with psoriasis, 94% of the patients with AD and 53% of the healthy subjects had vitamin D insufficiency. NB-UVB treatment produced a statistically significant ($p < 0.001$) increase in serum calcidiol, the increase being 59.9 nmol/l in psoriasis, 68.2 nmol/l in AD and 90.7 nmol/l in healthy subjects. The psoriasis area and severity index (PASI) and SCORAD improved significantly, but no correlation with the increase of serum calcidiol was found. The expression of two antimicrobial peptides, cathelicidin and human β-defensin-2 (HBD-2), was high in psoriasis skin lesions. The expression of HBD-2 decreased in NB-UVB-treated psoriasis and AD skin lesions, but the expression of cathelicidin increased. This effect might be mediated by improved vitamin D balance and the local cytokine network.

To conclude, the present studies in healthy subjects and patients with AD and psoriasis show that vitamin D insufficiency is still prevalent in Finland in winter. Sunlight during heliotherapy or small doses of NB-UVB, which are clearly below the skin's erythemal threshold, effectively induced vitamin D synthesis, and, at the same time, improved the clinical course of AD and psoriasis. NB-UVB exposures given on the whole body or on the head and arms were equally effective in increasing serum calcidiol. The NB-UVB exposures, given three times a week for a total of 15 times on the whole body, effectively corrected vitamin D insufficiency. Serum calcidiol increased up to 59.9–90.7 nmol/l and this high level persisted for at least one month. Suberythemal NB-UVB exposures seem to be a good alternative to correct vitamin D deficiency or insufficiency quickly and safely, but further studies are warranted to compare the effects and costs with dietary vitamin D supplementation.