

Water-filtered infrared-A radiation (wIRA) is not implicated in cellular degeneration of human skin

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Abstract

Background: Excessive exposure to solar ultraviolet radiation is involved in the complex biologic process of cutaneous aging. Wavelengths in the ultraviolet-A and -B range (UV-A and UV-B) have been shown to be responsible for the induction of proteases, e. g. the collagenase matrix metalloproteinase 1 (MMP-1), which are related to cell aging. As devices emitting longer wavelengths are widely used in therapeutic and cosmetic interventions and as the induction of MMP-1 by water-filtered infrared-A (wIRA) had been discussed, it was of interest to assess effects of wIRA on the cellular and molecular level known to be possibly involved in cutaneous degeneration.

Objectives: Investigation of the biological implications of widely used water-filtered infrared-A (wIRA) radiators for clinical use on human skin fibroblasts assessed by MMP-1 gene expression (MMP-1 messenger ribonucleic acid (mRNA) expression).

Methods: Human skin fibroblasts were irradiated with approximately 88% wIRA (780-1400 nm) and 12% red light (RL, 665-780 nm) with 380 mW/cm² wIRA(+RL) (333 mW/cm² wIRA) on the one hand and for comparison with UV-A (330-400 nm, mainly UV-A1) and a small amount of blue light (BL, 400-450 nm) with 28 mW/cm² UV-A(+BL) on the other hand. Survival curves were established by colony forming ability after single exposures between 15 minutes and 8 hours to wIRA(+RL) (340-10880 J/cm² wIRA(+RL), 300-9600 J/cm² wIRA) or 15-45 minutes to UV-A(+BL) (25-75 J/cm² UV-A(+BL)). Both conventional Reverse Transcriptase Polymerase Chain Reaction (RT-PCR) and quantitative real-time RT-PCR techniques were used to determine the induction of MMP-1 mRNA at two physiologic temperatures for skin fibroblasts (30°C and 37°C) in single exposure regimens (15-60 minutes wIRA(+RL), 340-1360 J/cm² wIRA(+RL), 300-1200 J/cm² wIRA; 30 minutes UV-A(+BL), 50 J/cm² UV-A(+BL)) and in addition at 30°C in a repeated exposure protocol (up to 10 times 15 minutes wIRA(+RL) with 340 J/cm² wIRA(+RL), 300 J/cm² wIRA at each time).

Results: Single exposure of cultured human dermal fibroblasts to UV-A(+BL) radiation yielded a very high increase in MMP-1 mRNA expression (11 ±1 fold expression for RT-PCR and 76 ±2 fold expression for real-time RT-PCR both at 30°C, 75 ±1 fold expression for real-time RTPCR at 37°C) and a dose-dependent decrease in cell survival. In contrast, wIRA(+RL) did not produce cell death and did not induce a systematic increase in MMP-1 mRNA expression (less than twofold expression, within the laboratory range of fluctuation) detectable with the sensitive methods applied. Additionally, repeated exposure of human skin fibroblasts to wIRA(+RL) did not induce

MMP-1 mRNA expression systematically (less than twofold expression by up to 10 consecutive wIRA(+RL) exposures and analysis with real-time RT-PCR).

Conclusions: wIRA(+RL) even at the investigated disproportionally high irradiances does not induce cell death or a systematic increase of MMP-1 mRNA expression, both of which can be easily induced by UV-A radiation. Furthermore, these results support previous findings of *in vivo* investigations on collagenase induction by UV-A but not wIRA and show that infrared-A with appropriate irradiances does not seem to be involved in MMP-1 mediated photoaging of the skin. As suggested by previously published studies wIRA could even be implicated in a protective manner.

Used abbreviations: BL: blue light; IR-A: infrared-A; MMP-1: matrix metalloproteinase 1; mRNA: messenger ribonucleic acid; PBS: phosphate buffered saline; RL: red light; UV-A, UV-A1, UV-B: ultraviolet-A (315-400 nm), -A1 (340-400 nm), -B (280-315 nm); wIRA: water-filtered infrared-A (780-1400 nm).