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Beneficial Effect of the QiHome® Air on Cultured Neuronal and Inflammation-Mediating Cells

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Abstract

Background: External environmental influences can cause an increased generation of reactive oxygen species in the body, which overwhelm the body's own antioxidant enzyme systems. The result is oxidative stress, which can damage cells and organs which then might cause neuronal dysfunction and even neurodegenerative and neuroinflammatory processes. The Gitterchip technology by QiBlanco as used in the QiHome® Air forms a static field that stimulates water molecules to undergo a transition into the coherent state. Since our body consists of about 70-85% of water, the coherent state of the water molecules should be able to influence the cells of our whole body in a positive manner against environmental influences.

Experimental: Based on the knowledge of neurodegeneration and neuroinflammation, neuronal cells (SH-SY5Y cells) and inflammation-mediating cells (HL-60 cells differentiated to functional neutrophils) were used in this in vitro study.

Results: The QiHome® Air had positive effects on all parameters tested in this in vitro study compared with untreated controls. Peripheral neuronal cell regeneration was significantly improved by 53.3 ± 6.4 % compared to untreated control cells ($p \leq 0.01$; Wilcoxon-Mann-Whitney two-tailed rank sum test). In addition, also neuronal cell viability/survival after environmental oxidative stress was markedly increased by the QiHome® Air exposure compared to untreated controls by 34 % at 1 mM hydrogen peroxide and more than 80 % at 1.5 mM hydrogen peroxide ($p \leq 0.01$). Compared to the untreated controls, exposure to the QiHome® Air resulted in a pronounced and statistically significant increase ($p \leq 0.01$) in the basal metabolism of functional neutrophils by 20.7 ± 8.0 %. In contrast, the generation of reactive superoxide anion radicals was significantly reduced by the QiHome® Air by 16.4 ± 4.1 % compared to the untreated controls ($p \leq 0.01$)

Conclusions: Oxidative stress plays a central role in the damage of peripheral and central nerve cells and the development of many neurological disorders and diseases.

As demonstrated in the cell-based assays presented here, exposure to the QiHome® Air has beneficial properties that might counteract environmental disturbances leading to neurodegeneration, neuroinflammation and the associated functional disorders in a complex organism, thus, maintaining and improving individual well-being and neuronal health.

1. Introduction

Environmental influences such as industrial chemicals, xenobiotics, air pollution, ultraviolet and ionizing radiation, electromagnetic and geopathogenic radiation and many others can cause an increased formation of reactive oxygen species in the body, which overwhelm the body's own antioxidant enzyme systems [1-4]. The result is oxidative stress, which can damage cells and organs. In the nervous system, for example, damage to lipids, proteins, and DNA can cause neuronal dysfunction and even neurodegenerative and neuroinflammatory processes [5-8]. In dementia, oxidative damage in the mitochondria, amyloid beta and tau deposits, and inflammatory processes are associated with these diseases [9,10]. Moreover, acute and chronic inflammatory processes are also related to an excess of radicals in the tissue caused by an oxidative burst of inflammation-mediating cells such as neutrophils [11,12].

Previous studies using the QiBlanco Gitterchip technology have shown its beneficial effects on cellular level [13-16]. The Gitterchip technology forms a static field that stimulates water molecules to undergo a transition into the coherent state. Since our body consists of about 70-85% of water, the coherent state of the water molecules [17-19] should be able to influence the cells of our whole body in a positive manner [20-22]. This Gitterchip technology is represented here by the QiHome® Air which is recommended to optimize the environmental conditions in living and workspaces. Especially electromagnetic fields due to mobile phone or radio waves as well as geopathogenic disturbances, which themselves represent an additional radiation exposure on top of technically generated radiation, might cause general health issues in people with higher individual sensitivity.

In this animal-free study with cultured organ-specific cells, the effects of the QiHome® Air were investigated at the cellular level. Based on the knowledge of neurodegeneration and neuroinflammation, both neuronal and inflammation-mediating cell lines were used in this study.

2. Materials and Methods

2.1. QiHome® Air and basic experimental setup

The QiHome® Air is a specialized device that differs from traditional air purifiers which only remove physical and biological particles, as it focuses primarily on harmonizing electromagnetic and geopathogenic fields from the environment and structuring water in the indoor air by the Gitterchip technology [16]. The basis is the same Gitterchip technology as for the QiOne® 2 Pro (QTA-T-333) and QiBracelet® (QTA-O-400), but in its QTA-U-5000 version, which is coupled to a laser quartz amplifier (elongated rock crystal). This results in a total system output which is approximately 100 times stronger as that of a QiOne® 2 Pro.

For the experiments presented here, the QiHome® Air-exposed cells and the control cells were cultivated in two separate mini incubators at 37 °C in a pH-stable culture medium (RPMI 1640/Leibovitz L-15 (1+2) supplemented with 10 % growth mixture, 20 mM HEPES buffer and standard amounts of antibiotics). The mini incubators were located in two houses about 1.5 km linear distance apart so that a mutual influence between the cell cultures could be excluded. Moreover, the use of the mini-incubators guaranteed identical cell culture conditions. For the duration of the experiments, i.e. 10 hours for regeneration, 24 hours for oxidative stress and the last three days of differentiation of human promyelocytes to functional neutrophils, cells were either exposed to the QiHome® Air which was placed about 2 meters beside the mini incubator or were cultivated without its exposure. Thus, the environmental disturbances were influenced by the QiHome® Air or acted as the normal background radiation on the cells. The experiments were performed over a period of several weeks.

2.2. Cell culture

SH-SY5Y cells are a clonal subline of a neuroepithelioma cell line that had been established in 1970 from the bone marrow biopsy of a 4-year-old girl with metastatic neuroblastoma. The cell line is a valuable in vitro model for functional studies in neurobiology and research on neurodegenerative diseases or neurological disorders [23-25].

The SH-SY5Y cells (ACC 209; DSMZ Leibniz Institute, Braunschweig, Germany) were routinely cultivated as mass cultures in a culture medium consisting of DMEM with 1.0 g/L glucose and Ham's F12 (1+1), supplemented with 10 % growth mixture and standard amounts of antibiotics. The cells for the experiments were taken from 80 to 90 % confluent mass cultures in internal passage 17 to 25.

The second cell type of this study were human promyelocytes (HL-60; ACC 3, DSMZ Leibniz Institute, Braunschweig, Germany) which were differentiated to

functional neutrophils able to undergo an oxidative burst upon phorbol ester stimulation similar to primed neutrophils [26-28]. HL-60 cells were cultivated as suspension mass cultures in RPMI 1640 medium supplemented with 10 % growth mixture and standard amounts of antibiotics. The cells for the experiments were taken from mass cultures in internal passage 12 to 26.

Cultivation was always carried out in an incubator at 37 °C in a humid atmosphere of 5 % CO_2 and 95 % air. The cells were regularly transferred twice a week to new cell culture flasks at a lower cell density for further growth.

2.3. Examination of cell regeneration

SH-SY5Y cells were seeded at a density of 200,000 cells/mL into the four individual compartments of a silicone 4 well-culture insert (ibidi, Gräfelfing, Germany). The single compartments of the inserts are separated by 500 µm thick silicone bars. Due to the special adhesion area, each insert adheres firmly to the bottom of a culture dish and forms a distinct cell-free area, which the cells can colonize by migration and proliferation after removal of the silicone frame. This in vitro model is only related to the peripheral nervous system.

Upon reaching confluency within 48 hours after cell seeding and directly after removal of the insert, the cells were exposed to the QiHome® Air until the end of the experiment. The control cultures were handled simultaneously in the same manner without use of the QiHome® Air. After 10 hours of continuous incubation, cell cultures were washed with phosphate-buffered saline, fixed with methanol, stained with Giemsa's methylene blue solution (Sigma-Aldrich, Deisenhofen, Germany) and were air-dried.

Micrographs documenting the residual cell-free area were done at different locations for each sample. A total of 4 measurements of the remaining cell-free area was carried out for each independent test series. IKOSA AI software with artificial intelligence (Kolaido, Altenrhein, Switzerland) was used to calculate the residual cell-free area for the treated cell cultures in comparison to untreated controls. Four independent experiments were performed, each with three replicates.

2.4. Examination of environmental oxidative stress

SH-SY5Y cells were seeded into 96-well culture plates (200 µL culture medium/well) at three different cell densities (200,000, 100,000 and 50,000 cells/well) and incubated for 24 hours until the cells had completely adhered and restored their metabolism. Then, cells were treated with hydrogen peroxide concentrations ranging from 0.5 to 1.5 mM in the culture medium with and without exposure to the QiHome® Air for the duration of the experiment. After 24 hours of hydrogen peroxide exposure, cell viability was examined by incubation of the cells to a reaction mixture consisting of 180 µL/well of culture medium and 20 µL/well of XTT (Xenometrix, Allschwil, Switzerland). The cleavage of the dye is directly proportional to the mitochondrial dehydrogenases activity. Finally, the optical density was measured as a difference measurement ΔOD = 450 – 690 nm at definite time points by an Elisareader (BioTek ELx808 with software Gen 5 version 3.00) and analyzed using Microsoft Excel. Three independent experiments with replicates for each experiment were performed.

2.5. Examination of endogenous radical generation

Promyelocytes were cultivated as suspension mass cultures in special culture flasks with a vented cap (25 cm^2 growth area; TPP, Switzerland) so that an atmospheric gas exchange can be inhibited by turning the cap into another position. The cultured promyelocytes were differentiated into functional neutrophils by adding 1.5 vol% dimethyl sulfoxide for 6 days. On the last three days of differentiation, cells were kept in the mini-incubator near the QiHome® Air. The control cells remained in the mini-incubator without exposure to the QiHome® Air.

Finally, the cells of each experimental series were harvested by centrifugation (190 x g for 6 minutes) and were repeatedly washed in phosphate buffered saline with calcium and magnesium and centrifugation steps. Cells were resuspended in phosphate buffered saline with calcium and magnesium containing 10 mM glucose. 40 µL of the cell suspension aliquots were pipetted to a reaction mixture containing the tetrazolium dye WST-1 (Sigma-Aldrich, Deisenhofen, Germany) and phorbol-12-myristate-13-acetate for induction of an oxidative burst. Cells without addition of the phorbol ester served as internal controls reflecting the basal cell metabolism without stimulation. The generated reactive superoxide anion radicals in the reaction mixture caused the cleavage and color change of the dye. The amount of superoxide anion radicals present in the reaction mixture was directly related to this color change. The change in optical density was recorded at various time points up to 40 minutes as a differential measurement ΔOD = 450 – 690 nm by an Elisareader (BioTek ELx 808 with software Gen 5 version 3.00) and calculated with Microsoft Excel. Three independent experiments with replicates for each experiment were performed.

3. Statistical Analysis

Data are given as mean values ± standard deviations. Statistical analysis was done using the parameter-free two-tailed Wilcoxon-Mann-Whitney rank sum test and significance was determined at the 1 % ($p \leq 0.01$) level.

4. Results

4.1. Cell regeneration

The residual cell-free area after 10 hours of regeneration was only 11.8 ± 2.9 % of the total area for the cell cultures exposed to the QiHome® Air, while the residual area for the untreated control cells was 25.2 ± 5.3 %. In relation to the residual area, this corresponds to an improved regeneration by the QiHome® Air of 53.3 ± 6.4 % compared to untreated control cells. The difference was statistically significant ($p \leq 0.01$), which can also be seen in the micrographs at the end of the experiments (Figure 1). For an overview on the measurement data for each single experiment, see Figure 2.

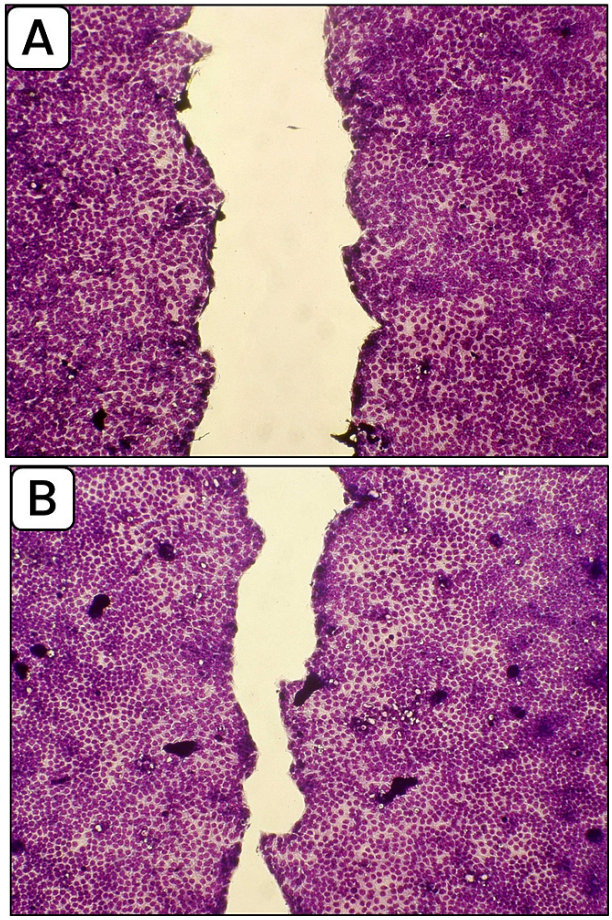

Figure 1: Representative micrographs of the regeneration without (A) and with (B) exposure to the QiHome® Air. Olympus IX50 inverted microscope with a 10x planachromate lens and Olympus E-20 digital camera at brightfield illumination.

4.2. Environmental oxidative stress

As expected, the viability of the cells decreased with hydrogen peroxide concentrations > 1 mM in the culture medium. However, at lower hydrogen peroxide concentrations we observed a moderate, but not significant, increase in cell survival by hydrogen peroxide. This increase in cell viability was much more pronounced after exposure of the cells to the QiHome® Air when compared with untreated control cells (Figure 3). Especially at both hydrogen peroxide

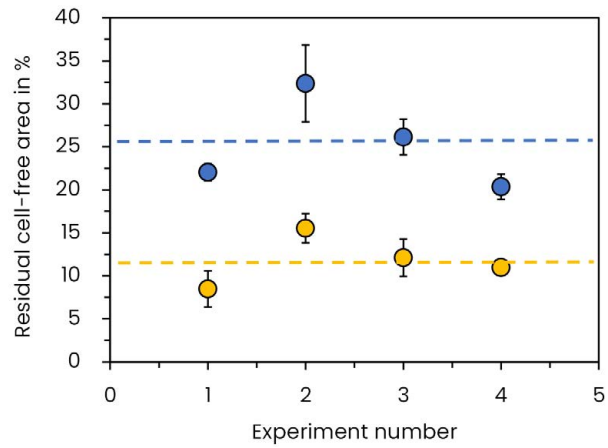

Figure 2: Graphical presentation of the regeneration values of four single independent experiments with SH-SY5Y cells after exposure to the QiHome® Air (yellow circles) in comparison to control cells without treatment (blue circles). Data points represent mean values ± standard deviations and the colored broken lines the corresponding mean values. The lower the residual cell-free area, the stronger is the stimulation of the regeneration process.

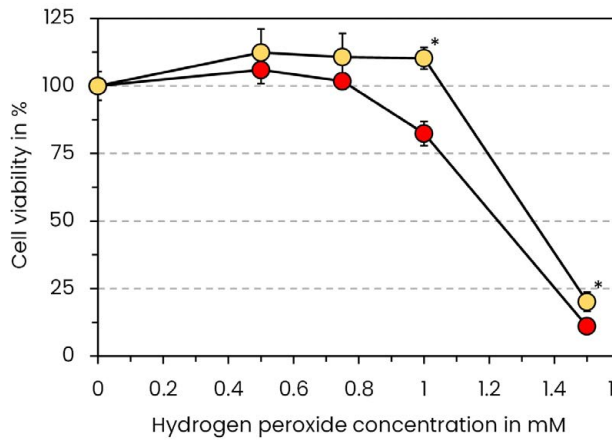

Figure 3: Dose-dependent effect of increasing hydrogen peroxide concentrations on the viability of SH-SY5Y cells treated with the QiHome® Air (yellow circles) in comparison to untreated control cells (red circles). Data points represent mean values ± standard deviations of three independent experiments. *$p \leq 0.01$; two-tailed Wilcoxon-Mann-Whitney test.

concentration of 1 and 1.5 mM, the cell viability was markedly increased by the QiHome® Air exposure by 34 % at 1 mM hydrogen peroxide and more than 80 % at 1.5 mM hydrogen peroxide, respectively. The difference to the untreated controls was statistically significant ($p \leq 0.01$).

4.3. Endogenous radical generation

Compared to the untreated controls, exposure to the QiHome® Air resulted in a pronounced and statistically significant increase ($p \leq 0.01$) in the basal metabolism of functional neutrophils by 20.7 ± 8.0 % suggesting a promotion in the innate immune defense of the blood. In contrast, the generation of reactive superoxide anion radicals was significantly reduced by the QiHome® Air by 16.4 ± 4.1 % compared to the untreated controls ($p \leq 0.01$). See the graphical presentation in Figure 4.

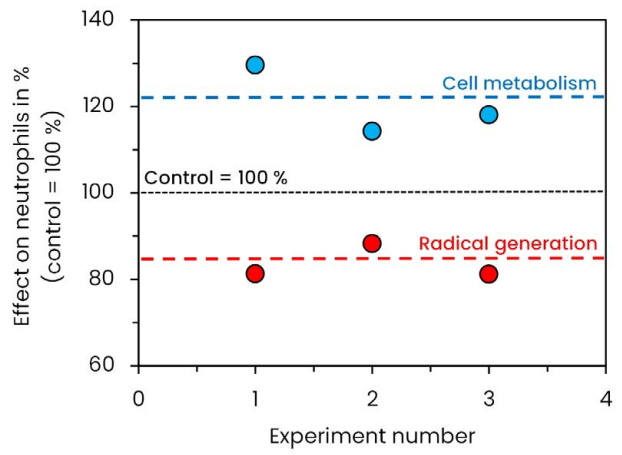

Figure 4: Presentation of the effect of the QiHome® Air after three days of exposure on functional neutrophils in all three independent experiments performed. In comparison to the corresponding controls (set as 100 %), the cell metabolism is always increased and the superoxide anion radical generation is always decreased (= anti-inflammatory effect).

5. Discussion

It is well-known that various environmental influences can act on the body and cause oxidative stress [2,29] which might result in neurodegenerative and neuroinflammatory processes [30,31]. Especially electromagnetic and geopathogenic stress coming from disturbances in the earth's natural energy flows and their potential physical and mental health effects have gained much attention within the last years [32-37]. Among these, health issues such as headaches, fatigue, and disrupted sleep patterns often have a negative impact on well-being and, subsequently, on overall health [38-40].

Prompted by this background we investigated the effect of the QiHome® Air on environmental influences. We focused in this animal-free study with cultured neuronal and inflammation-mediating cells on neurodegeneration and neuroinflammation in order to see whether coherent water structures, as induced by the exposure to the QiHome® Air, might be able to compensate the overall environmental influences.

Cell regeneration is a fundamental biological process that enables organisms to replace damaged or dead cells and thus maintain homeostasis. Promoting regeneration can result in an earlier restoration of the integrity and functionality of the affected tissue area. In most regenerating processes, the closure of a defect in a given structure requires the production of new cells. Therefore, one of the main functions of early signaling events after injury is to stimulate the production of additional cells that are able to rebuild lost or damaged structures. This is mostly done by cell proliferation, for example either proliferation of stem cells or of terminally differentiated cells [41,42]. In addition, the second fundamental cellular event during regeneration is the migration of cells [43]. However, physical injuries and neurodegenerative diseases often lead to irreversible damage and loss of function in the central nervous system. In mammals, such loss of function is due to the inability of these neurons to regenerate. Although the central nervous system has a limited capacity for self-healing in the early stages of embryonic development, this capacity decreases dramatically after birth [44]. Compared to the central nervous system, peripheral axons are able to regenerate after injury resulting in functional recovery and reinnervation of their target organs. However, this regenerative capacity is often incomplete and functional recovery is limited [45-48]. Our results have demonstrated that the QiHome® Air is able to promote the regeneration of peripheral neuronal cells in a significant manner in vitro, thus closing a nerve gap in a shorter period of time. However, the effect is not related to neurodegenerative disorders of the central nervous system [8].

Environmental oxidative stressors are external factors from the environment that increase the production of reactive oxygen species including oxygen radicals in the body, overwhelming the antioxidant defense system and leading to oxidative damage of cell components such as DNA, proteins, and lipids. The environmental stressors include air pollution, ultraviolet and ionizing radiation, pesticides, herbicides, industrial chemicals and solvents, chemical compounds, geopathic and electromagnetic fields [8]. Due to oxidative stress induced by environmental influences affecting our

body, the nervous system is one of the main targets resulting in neurodegenerative and neuroinflammatory processes causing neurological dysfunction, disorders or diseases [7,49,50].

A common in vitro model to simulate exogenous oxidative stress is the use of hydrogen peroxide as a donor for reactive oxygen species acting on cultured cells [51-53]. This in vitro model was also used here to examine whether QiHome® Air might be able to reduce external environmental oxidative stress. The measurement data demonstrate that the device acts as an antioxidant which might be able to reduce the effect of stressors by reactive oxygen species coming from the environment.

In addition, we also studied the effect of the QiHome® Air on the metabolism and endogenous superoxide anion generation of inflammation-mediating cells. Here we observed the effect that the metabolism of the functional neutrophils was increased, but the generation of reactive oxygen radicals was decreased (= anti-inflammatory effect). In vivo, polymorphonuclear neutrophils are short-living granulocytes with a very high turnover rate and known as frontline effectors of the innate immune defense [54]. The increased metabolism of the functional neutrophils might stimulate the turnover rate and, therefore, the efficacy of the innate immune defense of the blood [55-57].

The reduced radical generation of the functional neutrophils might cause a reduction of inflammation in the tissue. Related to nerve cells, this would mean that a neuroinflammatory process might be inhibited or slowed down. For example, oxidative stress has been shown to be a key factor in triggering neuroinflammatory processes and thus plays a central mechanistic role in the propagation of inflammatory cascades. Both hydrogen peroxide and nitric oxide anion radicals are oxidizing agents capable of penetrating cell membranes, regardless of whether they are generated extracellularly or intracellularly, thereby initiating complex signal transduction pathways [58].

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