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Research Article

Effect of Bioceramic Derived Irradiation in Patients Suffering From Ataxia

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Abstract

Objectives: The objective of this study was to determine the efficacy of irradiation using an apparel with Far-Infrared Radiation (FIR) properties for the management of dizziness and unsteadiness.

Participants: The study comprised 20 patients with dizziness and unsteadiness.

Intervention: Cranio-Corpo-Graphy (CCG) was performed before and after wearing a bioceramic garment.

Results: Significant reduction of longitudinal and lateral movements was noted.

Conclusion: Subjects exhibiting dizziness and unsteadiness benefited significantly when wearing a garment with FIR properties. It is tempting to speculate that the bioceramic membrane exerts its effect via the parasympathetic branch. However, an impact on multiple cerebello-cerebral loops, via modulation of the excitability of residual cerebellar circuits could be discussed as a mechanism of action. The exact mechanism has yet to be determined.

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Keywords

Bioceramic Membrane; Ataxia; Cranio-Corpo-Graphy

Introduction

C Far Infrared Radiation (FIR) is a subdivision of the electromagnetic radiation spectrum that has been investigated for biological effects [1]. The FIR band comprises the longest wavelengths ($\lambda = 3 - 100 \mu\text{m}$) of the infrared radiation band. In the past various studies provided evidence that far-infrared irradiation produces both non-thermal and thermal effects [2,3].

Most recently bioceramic materials, materials that emit Far-Infrared (FIR) rays, have attracted increasing attention for therapeutic purposes [4]. Nanoparticles of such ceramic materials can be incorporated into fibers then woven into fabrics and manufactured into wearable apparel. The principle source of energy needed to power the FIR emission from the garments originates from the human body. Energy from the human body is transferred to these ceramic particles which are acting as “absorbers”, maintain their temperature at sufficiently high levels and then emit FIR back to the body [1]. The body can experience energy of FIR as a radiant heat which can penetrate up to 4 cm beneath the skin. Elevation of skin temperature observed suggests that this might result in the acceleration of percutaneous blood circulation [5]. Such apparel has been linked to positive physiological effects. These wavelengths of far-infrared light may influence intracellular processes, affecting heat transfer in subcutaneous tissues and other physiologic processes [6,7]. Different studies implied that FIR irradiation can be an effectively employed for the treatment of patients suffering from phantom pain, fibromyalgia, postoperative pain, and chronic pain [8-16].

Decline of balance function is considered one of the factors likely to be responsible for falls in a large percentage of older adults [17-19]. As we age, balance function starts to decline and control of stance can become difficult for many older adults. In this context it is interesting to note that bioceramic fabrics improves postural control in young non-athlete participants and expert gymnasts [20]. Thus, it would be important to investigate whether bioceramic garments could improve balance stability in patients suffering from ataxia.

In ataxia, the fluid interplay of movement sequences is disturbed. This can affect gross motor processes such as walking or standing as well as fine-tuning the smallest muscle groups, for example when speaking or seeing. A distinction is therefore made between different forms of ataxia depending on the affected body region.

Ataxia is a generic term for various disorders of movement coordination, the process or the fine control of individual movements and the interplay of complex movement sequences. Ataxia can occur when the muscle strength is fully retained, but also in combination with symptoms of paralysis. When ataxia is not hereditary, it is mainly caused by damage to the cerebellum, brain stem, spinal cord, or peripheral nerves. The most obvious form of ataxia is gait ataxia or gait uncertainty. Affected people walk unsteadily, deviate from the straight gait

or take safety steps to the side. Mainly involved are the cerebellum as the “center of equilibrium” and its connections to the cerebrum, the midbrain, the brain stem, the spinal cord, the organ of equilibrium, i.e. the labyrinth in the inner ear (vestibular apparatus) and the peripheral nerves. The cerebellum is particularly capable of coordinating the activity of various muscles in complex, often unconscious movements [21-23].

Method

To test the effect of bioceramic irradiation patients complaining of dizziness and unsteadiness were submitted to a so-called ultrasound Cranio-Corpo-Graphy (CCG) (Zebris Medical GmbH, Isny, Germany). Fundamental of the measurement is the provocative test of standing trial by Romberg. The Romberg test is used to diagnose disorders of balance and coordination of movements (ataxia). It has been clearly demonstrated that the Romberg test is an appropriate approach to measure the degree of disequilibrium caused by the central vertigo, peripheral vertigo and head trauma. Subject is asked to stand erect with feet together and eyes closed. The spatial positions are measured by ultrasonic transmitters; two of which determine the position of the head and the other two determine the position of the shoulder. The resulting pattern of movement of the head and body are recorded and allow during and after the measurement, a direct evaluation of the results. There is an automatic analysis of the longitudinal and lateral movements. The results are automatically calculated and archived. The measuring system consists of a sensor with stand, adapter, marker set (special marker helmet and shoulder markers) and the analysis software. Romberg's test is positive if there is a tendency to sway or fall when the eyes are closed, or if a tendency to sway or fall when the eyes are open increases [24-26]. Subsequently the recorded data are submitted to a statistical analysis. The basis of this test is the intact interaction of proprioception, vestibular input, and vision. In general, with at least two intact systems a person should exhibit a fair degree of balance. The key to the test is that vision is taken away, meaning the subject is asked to close the eyes. Thus, with only two of the three systems remaining, the patient will become more imbalanced if a vestibular or a sensory disorder is present (Table 1).

Ataxia patients were recruited from ENT ward, university of Würzburg. Only patients with an anterior - lateral sway greater 11,5 cm and a lateral sway greater 10,5 cm and older than 18 years were allowed to participate in the study. Exclusion criteria were defined as follows: (a) sedative hypnotics, antidepressants, or anxiolytics less than 4 weeks; (b) patients with psychotic disorders, substance-related disorders, (c) abnormal laboratory tests of liver function and renal function; (d) pregnancy; (e) any physical or mental condition that, at the discretion of the examiner, does not allow safe or meaningful participation in the study (f) life expectancy < 3 months, (g) unwillingness to sign the informed consent form.

Following the CCG baseline measurements the patients were requested to wear an apparel with FIR properties (AE2M GROUP CONTINO, Uxegney, France) for a minimum of 60 minutes before performing a second CCG measurement.

Gender	Number	Age
Male	9	67 ± 9 years
Female	11	63 ± 9 years

Table 1: Demographics of patients tested.

Results

The ultrasound CCG was performed in a total of 20 subjects all suffering from ataxia. In all cases the exposure to bioceramic irradiation lead to an improvement of the longitudinal and lateral sways. Below the case of a 72 year old male suffering from ataxia (cause unknown, duration 1 year) is illustrated. Patient was submitted to a CCG examination. The test was performed under the condition eyes closed without and with exposure to bioceramic irradiation (Fig. 1 and 2).

Representative Case

Without bioceramic membrane

Figure 1: Illustration of longitudinal and lateral movements when subject is not exposed to bioceramic irradiation.

Figure 2: Illustration of longitudinal and lateral movements when subject is exposed to bioceramic irradiation.

The results of 20 patients subjected to CCG were submitted to a statistical analysis. The data analysis clearly indicated that bioceramic irradiation lead to a significant reduction of both the lateral and the longitudinal sways, however the strongest effect was noted for the lateral sway (Table 2).

	Without BCM Irradiation (n=20)	With BCM Irradiation (n=20)	Significance
Longitudinal sway	16,62 ± 3,15 cm	13,27 ± 3,83 cm	p< 0,0001
Lateral sway	15,06 ± 2,29 cm	12,48 ± 2,01 cm	p< 0,0001

Table 2: Alterations induced on longitudinal and lateral sways (in patients suffering from ataxia) when exposed to bioceramic derived irradiation.

Discussion

Ataxias are disorders of the coordination of movements, which can be triggered by a variety of diseases such as spinocerebellar degeneration Multiple Sclerosis (MS) and stroke [39-42], thus, leading to a loss of function of certain parts of the nervous system [27-42]. Usually the cerebellum is affected, but damage to the spinal cord or peripheral nerves can also lead to ataxias. Diseases with loss of function of certain parts of the nervous system can cause ataxias. However, the most common cause is the damage to the cerebellum, which is responsible for coordinating information from the spinal cord, the organ of equilibrium and the other senses. The cerebellum translates this information into motor movements.

Damage to the cerebellum, resulting from an injury or illness (acquired ataxia) or because the cerebellum or spinal cord degenerates because of an inherited faulty gene (hereditary ataxia),

will hamper its control functions concerning walking, sitting balance, limb co-ordination, eye movements and speech.

The main goal of therapies provided to patients with cerebellar ataxia is the recovery of motor function and activity of daily living. Therapies offered include medication, surgery and physical therapy [19,43-45].

Cause of ataxia and the extent of neuronal damage have a great impact on whether medication and surgery can be employed successfully [46,47].

Most recently Transcranial Magnetic Stimulation (TMS) and transcranial Direct Current stimulation (tDCS)) were employed for treating patients with ataxia leading to an improvement of gait ataxia, limb ataxia, tremor, blood flow in the cerebellar hemisphere [48-52]. However, the extent of the above improvements remains moderate.

To our knowledge we are the first to describe a significant beneficial effect in patients suffering from ataxia when exposed to bioceramic derived irradiation. Both, the longitudinal as well as the lateral sways exhibited a significant change, thus leading to a much more stable gait and stands. It is assumed that the bioceramic derived irradiation provokes mainly an effect via the autonomic nervous system, most likely affecting the parasympathetic branch. However, bioceramic irradiation might also exhibit an impact on multiple cerebello-cerebral loops, via modulation of the excitability of residual cerebellar circuits, thus improving ataxia associated symptoms.

The results imply that garments with FIR properties can be an effective therapeutic approach in patients suffering from ataxia. However, further studies are needed in order to validate our findings.

Conclusion

Subjects exhibiting dizziness and unsteadiness benefited significantly when wearing a garment with FIR properties. It is tempting to speculate that the bioceramic membrane exerts its effect via the parasympathetic branch. However, an impact on multiple cerebello-cerebral loops, via modulation of the excitability of residual cerebellar circuits could be discussed as a mechanism of action. The exact mechanism has yet to be determined.

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