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Original Paper

Some Peripheral Biofeedback Modules in the Treatment of Chronic Diseases in Children

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Abstract

Biofeedback therapy is a non-drug treatment in which patients learn to control bodily processes that are normally involuntary, such as muscle tension, blood pressure, or heart rate. In this paper we present results obtained with Electro Dermal Response (EDR) and Heart Rate Variability (HRV) applied as adjuvant therapy in chronic pediatric patients. The methodology can be used in scholar settings for stress reducing in pupils and teachers.

The evaluated group comprises children and adolescents with: a) cystic fibrosis (N = 40 mean age = 17.5 years ±23.18 SD); b) bronchial asthma (N = 35, mean age = 11.5 years ±18.84 SD); c) epilepsy (N = 45, mean age = 13.5 years ±15.34 SD); and d) diabetes mellitus (N = 30, mean age = 12.5 years ±12.3 SD).

Study showed that peripheral biofeedback is very helpful tool for chronic disorders in children. Both (EDR and HRV) methods confirmed changes on the stress level very significantly. This therapy is non-invasive, easy for application, children accept it with interest and it is cost-effective.

Keywords

biofeedback, chronic diseases, stress level

1. Introduction

Diseases which appeared in childhood can be divided in two general form: **acute**, short-term illnesses such as upper respiratory tract or ear infections, gastrointestinal illness with vomiting and diarrhea, or injury-related problems, and **chronic illness** (lasting for years or even lifelong) as a result of genetic (inherited) conditions, environmental factors, or a combination of both.

The definition of chronic condition comprises any medical condition that can reasonably expected to last at least 12 months and to involve either one or several different organ systems severely enough to require specialty paediatric care and probably some period of hospitalisation in a tertiary care centre (*Feudtner* et al., 2000).

The most frequent chronic illness in children in our country are diabetes mellitus, cystic fibrosis, epilepsy, asthma, cerebral palsy and developmental disorders. The statistic shows that in the last decade the number of chronic diseases is increasing worldwide. Generally, it was calculated that 13-27% of children are affected by chronic conditions globaly (Van Cleave et al., 2010).

Beside genetic factors, the so called "social ecology" of childhood cite as possible factors for increased number of chronic diseases the exposure to higher levels of toxic stress, increasing rates of absent parents, more sedentary lifestyles, more television and multimedia use, and high-calorie, high-fat diets, etc.

Chronic conditions affect many aspects of the lives of children with consequences that endure into adulthood (Juonala et al., 2011). However, better quality of healthcare during childhood can improve educational achievement and employment prospects and reduce disability and dependency of this population. Additionally, the child who is diagnosed with a serious and chronic medical illness is at greater risk for developing emotional problems which interfere with the prognosis (Wijlaars et al., 2016). All chronic diseases need highly specialized professional care, long-term follow-up, high cost medication or interventions and involvement and support of the family, siblings and larger environment.

1.1 The Aim

The aim of this article is to show some additional therapeutic modalities which happen to be very helpful to overcome the stress level in children with chronic diseases. For this reason we will explain the principles of biofeedback as well our results obtained with biofeedback therapy in some groups of chronic ill patients in pediatric settings.

2. Materials and Method

In this study we evaluated a group of children with chronic diseases, treated at the department of psychophysiology, University Children's Hospital-Skopje, Macedonia, in which we applied peripheral biofeedback as an additional therapeutic method.

The evaluated group comprises children and adolescents from both sexes with: a) cystic fibrosis (N = 40 mean age = 17.5 years ± 23.18 SD); b) bronchial asthma (N = 35, mean age = 11.5 years ± 18.84 SD); c) epilepsy (N = 45, mean age = 13.5 years ± 15.34 SD) and d) diabetes mellitus (N = 30, mean age = 12.5 years ± 12.3 SD).

Biofeedback therapy is a non-drug treatment in which patients learn to control bodily processes that are normally involuntary, such as muscle tension, blood pressure, or heart rate. Biofeedback modalities can be divided into peripheral (based on electromyography, Electro Dermal Response, heart rate, temperature, blood volume pulse) or central (based on electroencephalography (EEG), or so called

neurofeedback) (Schwartz, 1987).

Neurofeedback or EEG biofeedback refers to a specific operant-conditioning paradigm where an individual learns how to influence the electrical activity (frequency, amplitude or synchronization) of his brain. It involves teaching skills through the rewarding experience of inducing EEG changes reflected in a perceivable signal (light or sound).

Electro Dermal Response (EDR) is used in so called EDR biofeedback where sensors are attached around two fingers with an Electrodermograph (EDG) and measure the activity of sweat glands and the amount of perspiration on the skin, alerting the person to the state of anxiety. EDR is a complex reaction with a number of control centers in the central nervous system. Three systems related to arousal, emotion and locomotion are responsible for the control of the electrodermal activity (Boucsein, 1992). The reticular formation controls EDR related to states of arousal, the limbic structures (hypothalamus, cingulated gyres and hippocampus) are involved in EDR activity related to emotional responses and thermoregulation, while the motor cortex and parts of the basal ganglia are involved in locomotion. In particular, skin potential and skin conductance used as parameters in EDR biofeedback are related to both sympathetic and parasympathetic arousal (Andreassi, 2000; Mangina et al., 1996).

Treatment by EDR biofeedback is generally based on training patients in strategies for lowering arousal and maintaining a healthful Sympathetic/Parasympathetic tone. Consequently, EDR biofeedback modality is a first choice for introvert persons, where high inner arousal is a typical finding and biofeedback training is supposed to lower sympathetic arousal. Changes in electrodemal activity can be reliably detected within one second of stimulus presentation, often following a single event (Kropotov, 2009). It is important to know that electrodermal conductance precede any other signals related to neuroimaging such Positron Emission Tomography (PET), Blood Oxygen Level-Dependent functional magnetic resonance (BOLD), Single Photon Emission Computed Tomography (SPECT), etc. which must be used in practice. In other words, the changes of electroderamal activity can be registered before the changes obtained by the other neuroimaging techniques.

Heart Rate Variability (HRV) is a measure of the continuous interplay between sympathetic and parasympathetic influences on heart rate that yields information about autonomic flexibility and thereby represents the capacity for regulated emotional responding (Appelhans, 2006; Schwartz & Andrasik, 2003).

As HRV biofeedback instrumentation we used Heartmath Freeze-Framer System from HeartMath Institute. This relatively simple system is constructed to help in following area: to shift intentionally to more positive emotional state; to help in better problem solving; to maintain general health and physical resilience; to transform the stress into positive relationships and to help in effective dealing with stress. It is supposed that effective emotional regulation depends on being able to flexible adjust the physiological response to a changing environment.

For the EDR biofeedback we used Relax plus and Inner Tunner Professional, Ultramind, UK. EDR biofeedback sessions was generally based on training patients in strategies for lowering arousal and

maintaining a healthful sympathetic/parasympathetic tone.

After the initial assessment, interview with the parent and the child and analyzing the medical history and data of the child, 15 training sessions in a duration of 30 to 40 minutes were applied, twice per week. During the sessions, the patients were sitting in a comfortable chair, in a quiet room, along with the practionner. The instructions given to the patients were to try be calm and relax, try to breathe deeply, relax the body muscles and think about a pleasant life situations or persons they love. We based this instruction on the common knowledge that each thought has a corresponding physiological effect and can highly affect the general state of the mind and the body.

In this study we present our results obtained from EDR and HRV biofeedback. We have calculated Student *t*-test for the results obtained for the first and last sessions within the each group and ANOVA for the HRV between the groups.

3. Results and Discussion

For the EDR biofeedback measures are calculated in μΩ, and for the HRV biofeedback in percentage. Figures presented below are showing the first and the last session results for each group of patients.

Results obtained with EDR biofeedback for the group of Cystic Fibrosis (CF) are displayed on Figure 1. Calculated Student *t*-test, between first session (M = 23.9 ± 4.41SD) and last session (M = 57.16 ± 4.21SD; N = 40) is highly significant (*t* = -49.96 p = 0, 0000).

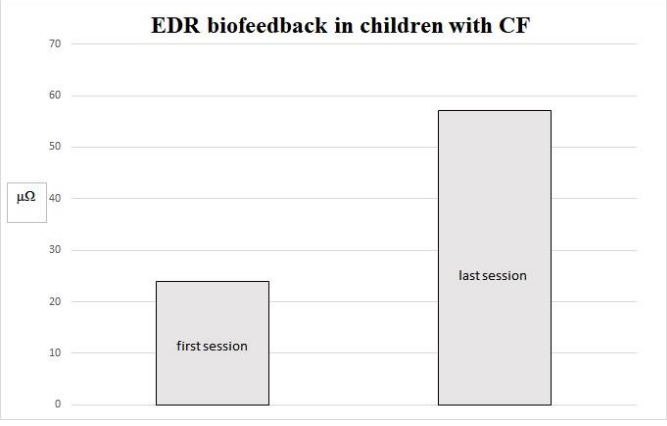

Figure 1. EDR Biofeedback in Children with CF

The level of relaxation with HRV biofeedback sessions is shown on Figure 2.

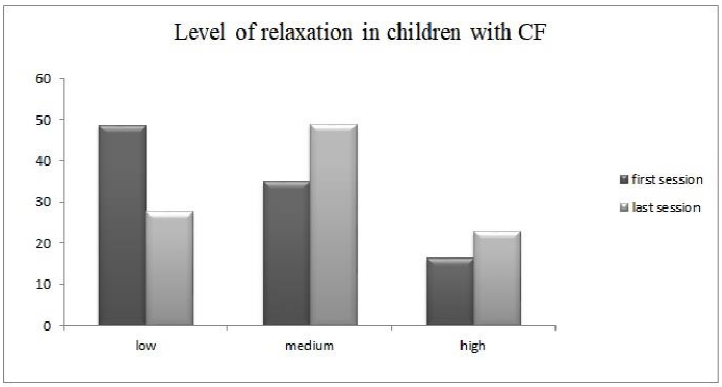

Figure 2. The Level of Relaxation during the HRV Biofeedback Sessions for Children with CF

For the group of asthmatic children, results obtained in EDR biofeedback is presented on Figure 3. Calculated Student *t*-test between the first session (M = 39.15 ± 5SD) and last session (M = 65.67 ± 3.23SD; N = 35) is highly significant (*t* = -48.57 p = 0, 0000).

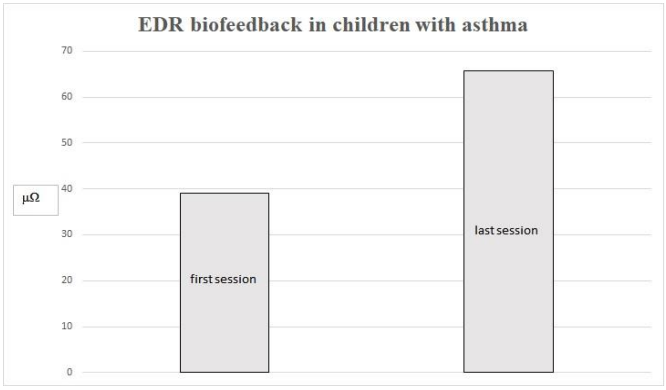

Figure 3. EDR Biofeedback in Children with Asthma

Additionally, we present the level of relaxation during HRV biofeedback sessions for asthmatic children (Figure 4).

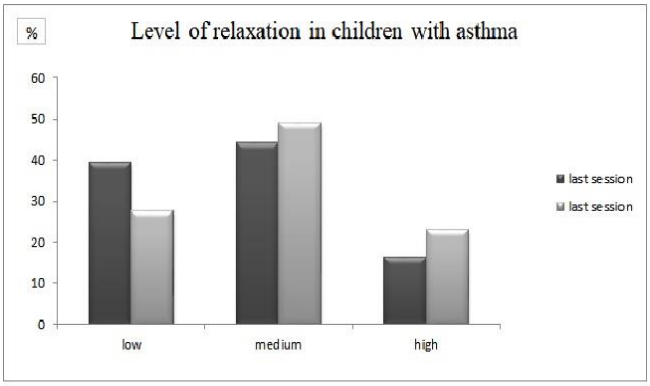

Figure 4. Level of Relaxation during HRV Biofeedback Sessions for Children with Asthma

Applied EDR biofeedback results for children with epilepsy are presented on Figure 5. Student *t*-test between first session (M = 35.73 ± 3.45SD) and last session (M = 62.92 ± 2.7SD; N = 45) was also highly significant (*t* = -67.55 p = 0, 0000).

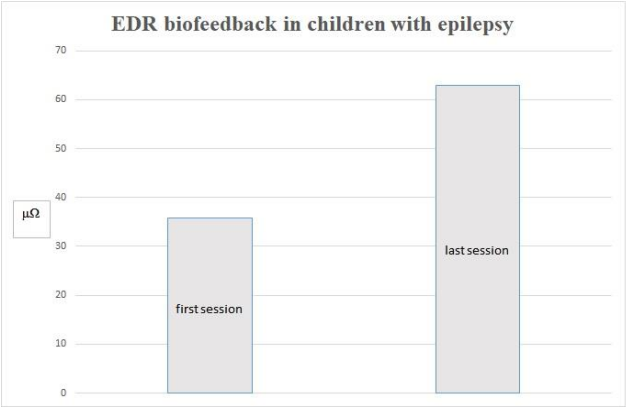

Figure 5. EDR Biofeedback in Children with Epilepsy

Furthermore, we present the level of relaxation during HRV biofeedback sessions for children with epilepsy (Figure 6).

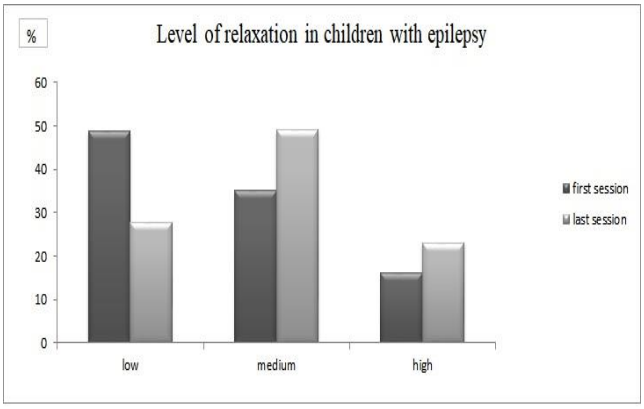

Figure 6. Level of Relaxation during HRV Biofeedback Sessions for Children with Epilepsy

For the group of diabetic children, results are presented on Figure 7. Calculated Student *t*-test between the first session (M = 33.92 ± 4.26SD) and last session (M = 59.42 ± 2.7SD; N = 30) is also highly significant (*t* = -51.73 p = 0, 0000).

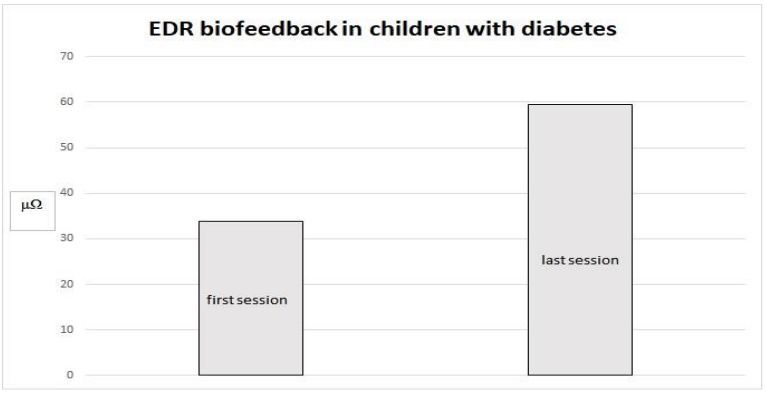

Figure 7. EDR Biofeedback Children with Diabetes

Level of relaxation during HRV biofeedback sessions in children with diabetes is shown on Figure 8.

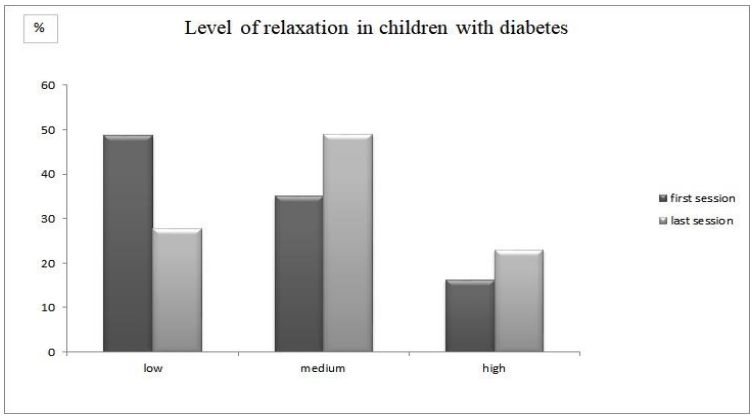

Figure 8. Level of Relaxation during HRV Biofeedback Sessions for Children with Diabetes

Results obtained with HRV for all groups are presented on Figure 9. For all groups we have calculated ANOVA, which is significant at the level $p < 0, 05$.

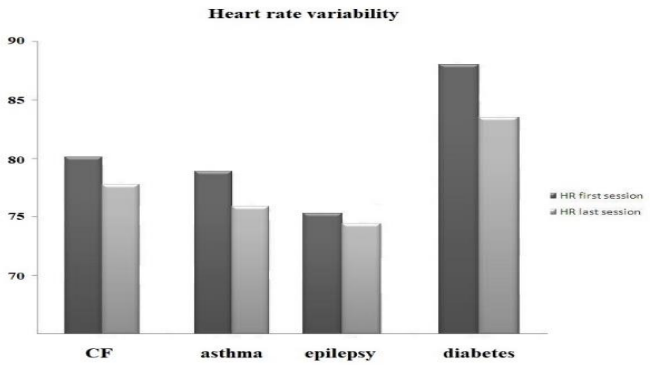

Figure 9. Comparison of Obtained Results for HRV for All Groups of Patients

As mentioned, HRV biofeedback was applied in all groups. Screen of HRV tool we use is presented on Figure 10.

Figure 10. HRV Biofeedback Tool Screen

4. Discussion and Conclusion

The biopsycholosocial framework, that recognizes the importance of the of mind-body interrelationship for the developing human being became relevant for the contemporary pediatric healthcare. Simultaneously, biofeedback has arisen as a modern computer-related operant conditioning technique used for assessment and therapy of many psychophysiological disorders, especially the stress-related ones. Its objective is to increase the voluntary control over the physiological processes that are otherwise outside awareness, using the information about them in the form of an external signal.

Various biofeedback approaches are increasingly used worldwide as non-pharmacological and cost-benefit effective research and therapeutic tools. A significant increase in research has documented the efficiency of biofeedback for children and adolescents that manifest behavioral, emotional and cognitive problems (Culbert et al., 1996; Scott, 1998; Pop-Jordanova, 1999; Schwartz, 1987). Unfortunately, biofeedback methods are not yet well known in pediatric settings.

We published our results obtained with biofeedback methodology for different group of disorders: eating disorders (Pop-Jordanova, 2000, 2003), somatoform disorders and ADHD (Pop-Jordanova, 2009). Especially we have very positive experience with neurofeedback in some groups of mental disorders like ADHD, OCD, depression, anxiety, etc. Obtained results corresponded with other researcher in this field (Pop-Jordanova & Zorcec, 2004; Pop-Jordanova, N. & Pop-Jordanov, J., 2002; Pop-Jordanova, 2008; Pop-Jordanova et al., 2005; Zorcec & Pop-Jordanova, 2009; Zorcec & Pop-Jordanova, 2008; Zorcec et al., 2007).

As conclusion we could point out that peripheral biofeedback is very helpful tool for stress-related disorders in children. In chronic patients it is successful in management with stress.

We propose this methodology as adjuvant for all chronic states. It is non-pharmacological, non-invasive, acceptable and interesting methodology for children. The only need is good motivation and support for family members. The methodology can be used in scholar settings for stress reducing in pupils and teachers.

The experience of the application of biofeedback methodology in school settings is very positive in Izrael. This method reduces stress in opupils and teachers, as well as in all administrative staff. The future research must be organized in this way.

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