Journal of Psychosomatic Research 93 (2017) 6–13

Contents lists available at ScienceDirect

Journal of Psychosomatic Research

Heart rate variability biofeedback therapy and graded exercise training in management of chronic fatigue syndrome: An exploratory pilot study

Petra Windthorst [a,*,1], Nazar Mazurak [a,1], Marvin Kuske [a], Arno Hipp [b], Katrin E. Giel [a], Paul Enck [a], Andreas Nieß [b], Stephan Zipfel [a], Martin Teufel [a]

[a] Department of Psychosomatic Medicine and Psychotherapy, University Hospital, University of Tuebingen, Germany
[b] Department of Sports Medicine, University Hospital, University of Tuebingen, Germany

ARTICLE INFO

Article history:
Received 14 December 2015
Received in revised form 27 November 2016
Accepted 29 November 2016

Keywords:
Heart rate variability biofeedback
Chronic fatigue syndrome
Graded exercise training
Quality of life
Depression

ABSTRACT

Objective: Chronic fatigue syndrome (CFS) is characterised by persistent fatigue, exhaustion, and several physical complaints. Research has shown cognitive behavioural therapy (CBT) and graded exercise training (GET) to be the most effective treatments. In a first step we aimed to assess the efficacy of heart rate variability biofeedback therapy (HRV-BF) as a treatment method comprising cognitive and behavioural strategies and GET in the pilot trial. In a second step we aimed to compare both interventions with regard to specific parameters.
Methods: The study was conducted in an outpatient treatment setting. A total of 28 women with CFS (50.3 ± 9.3 years) were randomly assigned to receive either eight sessions of HRV-BF or GET. The primary outcome was fatigue severity. Secondary outcomes were mental and physical quality of life and depression. Data were collected before and after the intervention as well as at a 5-month follow-up.
Results: General fatigue improved significantly after both HRV-BF and GET. Specific cognitive components of fatigue, mental quality of life, and depression improved significantly after HRV-BF only. Physical quality of life improved significantly after GET. There were significant differences between groups regarding mental quality of life and depression favouring HRV-BF.
Conclusion: Both interventions reduce fatigue. HRV-BF seems to have additional effects on components of mental health, including depression, whereas GET seems to emphasise components of physical health. These data offer implications for further research on combining HRV-BF and GET in patients with CFS.
Trial registration: The described trial has been registered at the International Clinical Trials Registry Platform following the number DRKS00005445.

1. Introduction

Chronic fatigue syndrome (CFS) is characterised by intense, disabling fatigue persisting more than six months that is not explained by on-going exertion or organic disease and that cannot be alleviated within a normal period by rest or distraction [1,2]. In addition, several physical or somatic symptoms, such as muscular pain, dizziness, headache, sleep disorder, inability to relax and/or irritability have to exist [3]. The prevalence of CFS varies widely depending on disease definition, but it is assumed that the syndrome could affect 1% of the adult population [1], and is more often seen in women and in adults [4,5,6]. Furthermore, there is an increased risk of completed suicide in patients with CFS [7]. Until now, no distinct agents either exclusively physiological or exclusively psychopathological have been identified [8]. Most promising theoretical concepts assume that the experience of fatigue and chronic physical symptoms combined with loss of functioning is influenced by multiple biological, affective, behavioural, cognitive, and social factors [6,8,9]. Wyller et al. [10] proposed a model of sustained arousal in patients with CFS based on the cognitive activation theory

Abbreviations: APT, adaptive pacing therapy; BF, biofeedback; BMI, body-mass index; CBT, cognitive behavioural therapy; CDC, Centers for Disease Control and Prevention; CFS, chronic fatigue syndrome; EEG, Electroencephalography; EMG, Electromyography; FSS, functional somatic syndromes; GET, graded exercise training; HRV, heart rate variability; MFI, Multidimensional Fatigue Inventory; RSA, respiratory sinus arrhythmia; SCID, structured clinical interview; SD, standard deviation; SDS, Somatoform Disorder Schedule; SF36, Short Form General Health Survey; SMC, specified medical care; QoL, quality of life.

* Corresponding author at: Department of Psychosomatic Medicine and Psychotherapy, University Hospital of Tuebingen, Osianderstraße 5, 72076 Tuebingen, Germany.
E-mail addresses: petra.windthorst@med.uni-tuebingen.de (P. Windthorst), nazar.mazurak@gmail.com (N. Mazurak), marvin.kuske@gmx.de (M. Kuske), arno.hipp@uni-tuebingen.de (A. Hipp), katrin.giel@med.uni-tuebingen.de (K.E. Giel), paul.enck@uni-tuebingen.de (P. Enck), andreas.niess@med.uni-tuebingen.de (A. Nieß), stephan.zipfel@med.uni-tuebingen.de (S. Zipfel), martin.teufel@med.uni-tuebingen.de (M. Teufel).
[1] Authors contributed to the paper equally.

http://dx.doi.org/10.1016/j.jpsychores.2016.11.014
0022-3999/

of stress (CATS) by Ursin and Eriksen [11]. This model takes into account predisposing (e.g. genetic traits such as polymorphisms in the autonomic and endocrine systems and personality traits such as inappropriate illness perceptions), precipitating (e.g. long-lasting infections, critical life events, and perceived chronic difficulties), perpetuating, and associated factors (e.g. hemodynamic, immune, endocrine, muscle, and cognitive alterations) [10]. The authors suggest that patients with CFS experience homeostatic instability as a result of precipitating factors, followed by vicious cycles of reinforced arousal response and dysfunctional cognitive beliefs that elicit a state of sustained arousal [10]. Similarly, Hyland [12] developed an extended network learning error theory of CFS to combine the psychological and immunological perspectives as well as that concerning the hypothalamic-pituitary-adrenal axis. He proposed that those three mechanisms interact and should be treated as complementary rather than as competing explanations within a network system. Knoop et al. [13] focused on the cognitive components. The authors described three different cognitive processes that may play a role in the maintenance of CFS: a general cognitive representation averse to fatigue, a process of focusing on fatigue, and specific dysfunctional beliefs about fatigue and activity.

Therapeutic approaches in patients with CFS are very limited. Three Cochrane reviews published thus far have summarised the evidence and suggested that cognitive behavioural therapy (CBT) and graded exercise training (GET) are effective therapies for patients with CFS [14,15,16]. The meta-analysis of Castell et al. [17] shows positive effect sizes for both CBT and GET and replicates the findings of previous reviews [18,19], but the research did not manage to find any significant difference between the two intervention types [17]. However, CBT seemed to emphasise the role of emotional aspects as perpetuating factors of fatigue and resulted in a greater reduction in depression and in anxiety [17]. In another randomised controlled trial that included 641 patients, White et al. [20] found CBT, GET, and adaptive pacing therapy (APT) in combination with specified medical care (SMC) to be more effective compared to SMC alone as a non-specific control condition. The long-term follow-up from this trial shows that the beneficial effects of CBT and GET were maintained for a median of 2.5 years after randomisation [21]. Moss-Morris et al. [22] analysed 49 CFS patients after a 12-week graded exercise programme in comparison to standard medical care. Patients showed less mental and physical fatigue and improved physical functioning. The authors stated that a decrease in symptom focusing, rather than an increase in fitness, mediated this treatment effect. Recently, Christensen et al. [23] highlighted the changes of illness perception as an important process in CBT for severe functional somatic syndromes (FSS). Concerning complementary medicine a recent systematic review provides limited evidence for the effectiveness of complementary and alternative-medicine therapy in relieving symptoms of CFS [24].

Biofeedback therapy (BF) is a treatment method that includes cognitive and behavioural strategies, and thus – based on the above mentioned – can be considered for application in the management of CFS patients. It comprises psychoeducational and interoceptive aspects, stress reduction and relaxation training, and improvement of self-efficacy in addition to the training of one or several specific parameters [25,26,27]. Heart rate variability biofeedback (HRV-BF) is a subtype of biofeedback training that aims to control ones breathing frequency at the level of 6 to 7 cycles per minute. Slow pace breathing has shown to increase a vagal tone, stimulate baroreflex regulation and contribute to the "restoration" of sympathetic/parasympathetic shift [28]. The most comprehensive review of HRV-BF by Wheat and Larkin [29] points out that changes in baroreflex activity could be the underlying physiological mechanism that explains beneficial effects of HRV-BF on health. HRV-BF has shown to be efficient in management of stress-related psychiatric disorders [30,31], chronic pain [32,33] as well as for the stress modulation in postpartum period [34] and in healthy subjects [35].

Surprisingly, our literature research revealed very few data about elaborated treatment protocols using HRV-BF in adult patients with CFS. In one study, 50 adolescents (ages 10–14) with CFS were treated with Electromyography- (EMG-) and HRV-biofeedback and compared with wait-list controls ($n = 42$), showing a significant reduction in fatigue severity and higher school attendance after intervention [36]. James and Folen [37] and Hammond [38] each reported single-case studies with EEG- biofeedback in a woman with CFS. Both reported considerable improvement in fatigue and cognitive functioning.

This led us to the idea to develop a HRV-biofeedback treatment manual for patients with CFS and to test its effect on fatigue perception as well as on self-estimated mental and physical functioning. Based on the evidence that HRV and respiratory sinus arrhythmia (RSA) trainings improve the regulation of the autonomic nervous system [28,39] which is affected in FSS as CFS [40], we chose breathing and heart rate as specific training parameters [25]. In regard to the maintaining cognitive and affective processes of CFS [13,41], we hypothesize that HRV-BF might help to normalise individual physiological reactions, to reflect specific dysfunctional beliefs about fatigue and activity, and to shift the point of concentration from fatigue to other aspects [42,43]. Based on Hyland's extended network learning error theory of CFS, HRV-BF might promote self-organisational learning at the interface between physiological and psychological events [12]. Finally, we thought about HRV-BF having an effect on the positive belief of personal control over one's symptoms, which has been proven to be an important mediating factor in the treatment of FSS [23,44].

If our HRV-BF protocol shall proof its efficacy in this pilot-study it could be used in further randomised placebo-controlled or "head-to-head" trials. Having this scope in mind, we added a well-established treatment for CFS management – graded exercise training – in order to observe their influence on our variables of interest. We aim to explore the impact of both treatment methods on subjective fatigue, mental and physical functioning as well as on depression. As a secondary outcome we compare the two interventions with regard to above mentioned mental and physical parameters.

2. Material and methods

2.1. Study population

The study was conducted at the Department of Psychosomatic Medicine and Psychotherapy, in collaboration with the Department of Sports Medicine, University Hospital Tübingen (Germany). Patients were recruited through advertisements in local newspapers and by an Internet web page. The local ethics committee of the medical faculty approved the study protocol (project number 310/2009BO2) in accordance with the Helsinki Declaration. All participants provided written informed consent prior to study participation.

Participants were screened according to the criteria for CFS of the Centers for Disease Control and Prevention (CDC) [3]. These criteria include the requirement of feeling extraordinary exhaustion after slight physical or mental activity, with no possibility of recovery within a normal period of time. In addition, several physical or somatic symptoms, such as muscular pain, dizziness, headache, sleep disorder, inability to relax and/or irritability have to exist. Four or more of these symptoms must be concurrently present for at least six months.

Prior to the inclusion of participants in the study, two structured clinical interviews – the structured clinical interview for DSM-IV Axis Disorders (SCID-I) [45] and the Somatoform Disorder Schedule (SDS) [46] – were conducted by an experienced psychologist (PW) with the purpose of estimation of inclusion and exclusion criteria.

Exclusion criteria included somatic or medical conditions that explained fatigue (e.g. cancer), substance abuse, a primary psychiatric disorder (e.g. schizophrenia), major depression or anxiety disorder, an ongoing psychotherapy or activation programme, and a body-mass index (BMI) lower than 18.5 kg/m^2 or higher than 35 kg/m^2. Based on current knowledge that more women than men who experience CFS seek treatment, we decided to include only females in this pilot study [4].