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· CLINICAL RESEARCH ·

Therapeutic effectiveness of electroencephalography biofeedback on children with attention deficit hyperactivity disorder

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Abstract

BACKGROUND: The treatment of attention deficit hyperactivity disorder (ADHD) by electroencephalograph(ECG) Biofeedback gradually receives attentions; however, there are few reports on classification researches of audition and visual perception.

OBJECTIVE: To explore the effectiveness of EEG biofeedback on children with ADHD.

DESIGN: A randomized self-controlled study before and after treatment.

SETTING and PARTICIPANTS: A total of 30 ADHD children who accorded with the diagnostic criteria of American Mental Disorder Diagnosis and Statistic Manuel(fourth edition) were selected for the study from Children's Mental Health Clinic of Nanjing Brain Hospital.

INTERVENTIONS: Children with ADHD were treated with EEG biofeedback therapy by the researching staff. Integrated Visual and Auditory Continuous Performance test(IVA-CPT) was used to evaluate before treatment and the therapeutic effectiveness after 20 and 40 times of the therapies.

MAIN OUTCOME MEASURES: Integrate feedback control quotient and integrate attention quotient.

RESULTS: After 20 times of treatments, the integrate feedback control quotient increased from 87.38 ± 15.71 to 98.56 ± 10.78, ($t = 4.59$, $P < 0.01$); integrate attention quotient increased from 70.38 ± 16.22 to 88.94 ± 16.37($t = 4.68$, $P < 0.01$). After 40 times of treatment, the integrate feedback control quotient increased to 107 ± 8.43($t = 5.38$, $P < 0.01$), and integrate attention quotient increased to 104.56 ± 12.67($t = 8.76$, $P < 0.01$). Each EEG biofeedback quotient significantly improved compared with that before therapy($P < 0.01$).

CONCLUSION: EEG biofeedback therapy has a confirmed therapeutic effectiveness, which requires more training time to treat children with obvious ADHD than those with hyperactivity-impulsion.

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INTRODUCTION

The treatment of ADHD by EEG biofeedback therapy gradually receives attentions recently[1,2]. In order to investigate the therapeutic effectiveness of EEG biofeedback therapy in the treatment of ADHD, the effectiveness of BFB 2000 EEG biofeedback therapy in Children with ADHD was preliminarily evaluated by IVA-CPT before and after treatment through self-controlled study.

SUBJECTS AND METHODS

Subjects

The study was designed into a self-controlled study. 30 children with a diagnose of ADHD aged from 7 to 13 years old were selected from Children Mental Health Clinic of Nanjing Brain Hospital from July 2001 to November 2002, in which there were 26 males and 4 females with a mean age of(8.6 ± 1.2) years old. All cases were in accordance with the ADHD diagnostic criteria set in American Mental Disorder Diagnosis and Statistic Manuel(the fourth edition, DSM-IV) with more than 80 points of intellectual quotient in Wais Intelligence Scale. All cases had no severe body diseases, nevous system diseases, and other childhood mental disorders.

Methods

EEG biofeedback therapy: BFB 2000 EEG biofeedback system was used to inhibit 4~8 Hz slow wave activity and increase 12~16 Hz sensory motor rhythm wave simultaneously. The EEG of the cases was collected by the system and feedback in the real time with all kinds of images. The frequency of the treatment was twice a week with each time of 45 minutes.

The tools and the methods for the evaluation of therapeutic effectiveness: IVA-CPT system is a system attached with the instrument, which observes four cognitive variables including missing, wrong choice, feedback time and stability, to obtain: visual or auditory feedback control quotient, and visual or auditory attention quotient through corresponding calculation for the final integrate feedback control quotient and integrate attention quotient and thereby to evaluate the condition of the patients. IVA-CPT was tested before the training and after every 20-time of trainings of each testee.

Statistical analysis: SPSS 11.0 software was used for paired t test by the author.

RESULTS

Before therapy, 7 cases had abnormal integrate feedback control quotient and 15 cases had abnormal integrate attention quotient and 8 cases had abnormities in both quotients. After 20-time treatment, the above integrate quotients became normal in 22 cases(73%, 22/30). After 40-time of treatment, the above integrate quotients became normal in 27 cases(90%, 27/30).

The comparison of integrate feedback control quotient and integrate attention quotients between before and after the treatment in ADHD kids was in Table 1. there was no significance in integrate feedback control quotient between 40-time treatment and 20-time treatment but there was significance in integrate attention quotient($t = 3.07$, $P < 0.01$).

Table 1 Comparison of integrate quotients between before and after therapy in ADHD patients ($\bar{x} \pm s$, $n = 30$)

Indices	Before therapy	20 times	40 times
Integrate feedback control quotient	87.38 ± 15.71	98.56 ± 10.78[a]	107.00 ± 8.43[c]
Integrate attention quotient	70.38 ± 16.22	88.94 ± 16.37[b]	104.56 ± 12.67[c]

vs before therapy, [a]$t = 4.59$, [b]$t = 4.68$, [c]$t = 5.38$, [d]$t = 8.76$, $P < 0.01$

The comparison of auditory or visual feedback control quotient and attention quotient between before and after treatment in ADHD kids was in Table 2. There were significant differences of auditory feedback control quotient and visual feedback control quotient between 40-time treatments and 20-time treatments but there were significant differences of auditory attention quotient($t = 3.97$, $P < 0.01$) and visual attention quotient($t = 2.36$, $P < 0.05$) between 40-time treatments and 20-time treatments.

There were complaints and obvious side effects during the entire study process.

Table 2 Comparison of auditory or visual feedback control quotient and attention quotient between before and after treatment in ADHD patients ($\bar{x} \pm s$, $n = 30$)

Indices	Before therapy	20 times	40 times
Auditory feedback control quotient	84.69 ± 17.21	100.81 ± 13.55[a]	109.60 ± 10.32[c]
Visual feedback control quotient	91.13 ± 13.43	96.44 ± 16.11[b]	103.56 ± 7.44[d]
Auditory attention quotient	72.88 ± 18.87	85.10 ± 14.51[b]	97.31 ± 17.42[d]
Visual attention quotient	73.63 ± 15.33	91.44 ± 19.20[d]	103.31 ± 17.42[b]

[a] $t = 4.32$, [b] $t = 4.08$, [d] $t = 4.37$, [c] $t = 9.87$, [e] $t = 4.98$, [f] $t = 5.30$, [b] $t = 11.78$, $P > 0.01$; [e] $t = 1.39$, $P > 0.05$, *vs those before treatment*

DISCUSSION

ADHD is one of the common behavioural problems in school age children, which has main clinical manifestation of loosing attentions, hyperactivity and impulsion that not in accordance with age[3,4]. The basic theory of the mechanism of EEG biofeedback therapy in the treatment of ADHD is to suppose the cerebral electric activity could be controlled and modulated through direct feedback training. Our results indicated that 73% of kids recovered after 20-time trainings. And 90% of them recovered after 40-time trainings. Therefore, the therapy of EEG feedback was effective in the treatment of ADHD. The researches conducted by Li[5], Li[6], Monastra[7] and Linden *etc*[8], all proved the effectiveness of EEG feedback therapy, which supported our results.

Central stimulant was the first choice in the previous treatment of ADHD and Ritalin was the drug commonly applied. As indicated by the literatures, after the administration of Ritalin, the effectiveness occurred fast with 70% of the patients having obvious improvements; however, it only could last for a short period but with obvious side effects[9] and moreover, it was easily cause relapse after the stop of taking medicine. Our study indicated that the therapy of EEG bioeedback had a unique effectiveness of preferable therapeutic effectiveness with a relative long period and less side effects, which could improve brain wave compared with that of Ritalin. Hence, EEG biofeedback could be the first choice in the treatment of ADHD.

Feedback control quotient mainly tests the integrate abilities of coordination and determination and its abnormity reflects a hyperactivity and impulsion control disorder in children. Attention quotient can measure the ability of attention and its abnormity often suggests some problems related with attention deficit. After the analysis of the results, it was obvious that the integrate attention quotient significantly improved after 40 times compared with that of after 20 times but no significant improvement in the comparison of integrate feedback control quotient, which suggested that most of the patients achieved preferable therapeutic effectiveness after 20-time training and the integrate attention quotient could be further improved over the increasing of training times. Therefore, the integrate feedback control quotient could be improved faster than integrate attention quotient. Attention disorder mainly relates with the deficiency in function of frontal temporal cortex, while hyperactivity and impulsion relate with the enhancement of dopaminergic neurons in corpus striatum. Our results suggested that the improvement in frontal temporal cortical function requires longer time of EEG feedback training then corpus striatum. Integrate attention quotient correlates with visual attention quotient and auditory attention quotients. Our study found that the change in auditory attention quotient was slower than visual attention quotient, which required 40-time trainings to achieve significant differences compared with that of before therapy. The above results might relate with the more complicate physiological process of auditory response than visual response and moreover, auditory attention is easier to be disturbed by environment. The research conducted by Jiang[10] *et al* pointed out: 20-time EEG biofeedback therapies could not improve auditory short-term memory. Attention closely relates with memory and thereby, their result indirectly supported our results.

In conclusion, EEG biofeedback therapy has confirmed therapeutic effectiveness in ADHD kids. After one course of 20-time treatments, most of the kids can achieve significant therapeutic effectiveness. The actual training time required will be better determined after the comparison of the IVA-CPT results between before and after the training.

REFERENCES

1 Lubar JF. Discourse on the development of EEG diagnostics and biofeedback for attention-deficit/hyperactivity disorders. *Biofeedback Self Regul* 1991; 16(3): 201－25
2 Jiang RH, Wang YF. The effect of EEG feedback on cognitive function of children with ADHD. *Zhongguo Xinli Weisheng Zazhi* 2002; 16(7): 462－4(China)
3 Wang J, Wang YF, Ren YC. A study of balance function on the subtypes of attention deficit and hyperactivity disorder. *Zhongguo Linchuang Kangfu* 2003; 7(19): 2715－7(China)
4 Zang YF, Gu BM, Qian QJ, *et al*. Objective measurement of the balance dysfunction in attention deficit hyperactivity disorder children. *Zhongguo Linchuang Kangfu* 2002; 6(9): 1372－3(China)
5 Li XN, Wang YF, Shu L, *et al*. A controlled study on the effectiveness of EEG biofeedback on attention deficit hyperactivity disorder. *Zhonghua Jingshenke Zazhi* 2001; 34(3): 168－71(China)
6 Li GX, Wu B, Chang SY. Diagnosis and treatment for child attention deficit and hyperactivity disorder by biofeedback electroencephalograph. *Zhongguo Linchuang Kangfu* 2003; 7(22): 3104－5(China)
7 Monastra VJ, Monastra DM, George S. The effects of stimulant therapy, EEG biofeedback, and parenting style on the primary symptoms of attention-deficit/hyperactivity disorder. *Appl Psychophysiol Biofeedback* 2002; 27(4): 231－49
8 Linden M, Habib T, Radojevic V. A controlled study of the effects of EEG biofeedback on cognition and behavior of children with attention deficit disorder and learning disabilities. *Biofeedback Self Regul* 1996; 21(1): 35－49
9 Efron D, Jarman F, Barker M. Side effects of methylphenidate and dexamphetamine in children with attention deficit hyperactivity disorder: a double-blind, crossover trial. *Pediatrics* 1997; 100(4): 662－6
10 Jiang RH, Wang YF, Gu BM. EEG biofeedback on cognitive function of children with ADHD. *Zhongguo Xinli Weisheng Zazhi* 2002; 16(6): 407－10(China)

脑电反馈治疗儿童注意缺陷多动障碍的疗效

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摘要

背景：脑电生物反馈治疗注意缺陷多动障碍（attention deficit hyperactivity, ADHD）逐渐受到关注，但听觉和视觉注意分类研究报告较少。

目的：探讨脑电反馈治疗 ADHD 的有效性。

设计：随机、治疗前后自身对照研究。

地点和对象：将南京脑科医院儿童心理卫生门诊符合美国精神障碍诊断与统计手册第4版标准的30例 ADHD 儿童作为研究对象。

干预：由研究组成员对研究对象进行脑电生物反馈治疗，分别于治疗开始前、训练20次及40次后用整合视听连续执行测试（integrated visual and auditory continuous performance test, IVA-CPT）对患儿评定。

主要观察指标：综合反应控制商数和综合注意力商数。

结果：经过20次训练，患儿综合反应控制商数由 87.38 ± 15.71，上升到 98.56 ± 10.78（$t = 4.59$, $P < 0.01$），综合注意力商数由 70.38 ± 16.22，上升到 88.94 ± 16.37（$t = 4.68$, $P < 0.01$）；经过40次训练，患儿综合反应控制商数上升到 107.00 ± 8.43（$t = 5.38$, $P < 0.01$），综合注意力商数上升到 104.56 ± 12.67（$t = 8.76$, $P < 0.01$），与训练前相比，各脑电反馈商数均有显著改善（$P < 0.01$）。

结论：脑电反馈治疗对 ADHD 的疗效肯定，对有明显注意缺陷患儿训练时间要比多动—冲动为主患儿训练时间为多。

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参考文献(10条)

1. Lubar JF Discourse on the development of EEG diagnostics and biofeedback for attention-deficit/hyperactivity disorders 1991(03)

2. Jiang RH. Wang YF The effect of EEG feedback on cognitive function of children with ADHD 2002(07)

3. Wang J. Wang YF. Ren YC A study of balance function on the subtypes of attention deficit and hyperactivity disorder 2003(19)

4. Zang YF. Gu BM. Qian Q J Objective measurement of the balance dysfunction in attention deficit hyperactivity disorder children 2002(09)

5. Li XN. Wang YF. Shu L A controlled study on the effectiveness of EEG biofeedback on attention deficit hyperactivity disorder 2001(03)

6. Li GX. Wu B. Chang SY Diagnosis and treatment for child attention deficit and hyperactivity disorder by biofeedback electroencephalograph 2003(22)

7. Monastra VJ. Monastra DM. George S The effects of stimulant therapy,EEG biofeedback,and parenting style on the primary symptoms of attention-deficit/hyperactivity disorder 2002(04)

8. Linden M. Habib T. Radojevic V A controlled study of the effects of EEG biofeedback on cognition and behavior of children with attention deficit disorder and learning disabilities 1996(01)

9. Efron D. Jarman F. Barker M Side effects of methylphenidate and dexamphetamine in children with attention deficit hyperactivity disorder:a double-blind,crossover trial 1997(04)

10. Jiang RH. Wang YF. Gu BM EEG biofeedback on cognitive function of children with ADHD 2002(06)

引证文献(3条)

1. 陈桂芳. 张开发 脑电生物反馈治疗注意缺陷多动障碍患儿的疗效评估现状[期刊论文]-中国组织工程研究与临床康复 2008(30)

2. 熊忠贵. 石淑华. 徐海青 儿童注意缺陷多动障碍视听整合连续性行为测试的应用评价[期刊论文]-中国妇幼保健 2006(5)

3. 熊忠贵 儿童注意缺陷多动障碍的综合研究[学位论文]博士 2006