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Neurofeedback Therapy in ADHD Treatment

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Psychopharmacology, especially metilfenidat, is still the main therapy to overcome ADHD problem. However, this type of psychopharmacology still has a lot of limitations. As an alternative, neurofeedback therapy is one of the forms of behavioral therapies with operant conditioning principles which train and condition the brain through its cerebral neurofeedback. This therapy is done by placing electrodes on the scalp to record cerebral neurofeedback. Neurofeedback therapy comes under neurobehavioural therapy which is designed for one to gather self-control through cerebral neurofeedback to apply in daily life. Quite a few researches have confirmed that neurofeedback therapy is beneficial and could be considered as one of therapy options for ADHD children.

Key words: ADHD, therapy, neurofeedback

Terapi psikofarmaka, terutama metilfenidat, masih merupakan terapi utama untuk gangguan ADHD, meskipun terdapat berbagai kekurangan dan keterbatasan. Sebagai alternatif, terapi *neurofeedback* adalah salah satu bentuk terapi perilaku, dengan prinsip *operant conditioning*, yang bertujuan melatih dan mengondisikan otak, dengan balikan gelombang listrik otak. Terapi ini dilakukan dengan pemasangan elektroda pada kulit kepala untuk melakukan perekaman aktivitas gelombang listrik otak. Terapi *neurofeedback* termasuk terapi *neurobehavioral* yang bertujuan untuk memperoleh pengendalian diri dengan melalui pengaturan aktivitas gelombang listrik otak untuk selanjutnya diterapkan dalam kehidupan sehari-hari. Berbagai penelitian telah menunjukkan bahwa terapi neurofeedback memberikan manfaat dan dapat dipertimbangkan sebagai salah satu pilihan terapi untuk anak dengan ADHD.

Kata kunci: ADHD, terapi, *neurofeedback*

Today, psychiatric problems in children which have been one of the major mental health problems are ADHD or hyperkinetic movement disorder (Barkley, 1998 & Saputro, 2004). Children with ADHD/ hyperactivity problems showed several problems: hyperactivity, inability to stay still, constant movements, inability to concentrate, and impulsiveness.

This disorder is categorized as chronic biological disorder in brain functions and could hinder responses as well as decision-making functions. Weaknesses in cognitive functions caused by this ADHD disorder are the decline of children's intelligence levels, decrease in academic achievement, bad timing, decrease in verbal and non-verbal memory, planning incompetency, insensitivity towards mistakes, and misbehavior. The difficulties in academic skills the children with ADHD experience are a variety of difficulties in reading, spelling, counting, and writing. This problem also brings constraints to children's language development (Barkley, 1998 & Saputro, 2004). A wide variety of research works done confirmed the worsening possible effects if this condition is intervened as early as possible and the effects are low academic achievements, school failures, and psychosocial problems at school and home. (Barkley, 1998; Plizska et al, 2000; Saputro 2004).

In the school age children population, ADHD prevalence rate ranged between 2-20%. In Indonesia, in elementary school children research (aged 6-13 years old) in Jakarta, the prevalence rate was 26.2% (comprising 15.9% ADHD children with difficulties in concentration, 5.3% ADHD children with combination types, 2.2% ADHD children with hyperactivity and impulsiveness (Saputro, 2004). Patients with ADHD are often affected with other psychiatric problems that reduces their adaptability in daily life and this lasts till they reach adulthood (Gilberg et al., 2004).

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Currently, psychofarmacology therapy, mainly metilfenidat, plays very important roles in major therapy despite weaknesses and limitations, like side effects, irresponsiveness to medicines, and rejection towards medicines. Multimodal therapy is one recommended therapy for handling ADHD in Europe and the USA and this covers psychofarmacology therapy, behavioral therapy, and family psychoeducation (Taylor et al., 2004, & The MTA Cooperative Group 1999). Administering behavioral therapy only could not generate satisfying results, especially for long-term effects (Abikoff, 1991, & Pelham et al., 1998 cited in Gevensleben et al, 2009).

Neurofeedback therapy is one form of behavioral therapies with operant conditioning principles to train and condition brain with cerebral neurofeedback. This therapy is given through placing electrodes on scalp to record activities of cerebral neurofeedback. Neurofeedback therapy includes neurobehavioral therapy which is designed for one to gain self-control through regulating cerebral neurofeedback activities to apply in daily lives (Gevensleben et al., 2009).

Method

To learn about how far neurofeedback therapy generates benefits in handling ADHD, a library research was done to summarize available research data based on the latest research works.

Results

ADHD Psychopathophysiology

ADHD known triggers till today are executive dysfunction and behavioral response disregulation related to dopaminergic pathways and noradrenergic corticosubcortical ones. The result of *event realted potential* (ERP) confirmed that ADHD children owned lower amplitudes and longer latency for a variety of ERP components, including N1, N2, mismatch negativity (MMN), *readiness potential* and P3b. This condition showed deficit in information processes and attentions (Klorman, 1991; Satterfield et al., 1994; Jonkman et al., 1997; Steger et al., 2001). In electroencephalography, ADHD patients consistently showed the existence of spectral activities dominated by low-speed frequency waves, like theta waves (4-7 Hz), especially in frontal areas, and the decrease of high speed frequency waves, as alpha waves (8-12 Hz) and beta (9-22 Hz) (Chabot et al., 1996; Monastra et al., 1999). In functional and volumetric brain imaging scan, there is a dysfunction of fronto-striatal system on ADHD patients (Casey et al.,1997). This condition is in accordance with the existence of high order motoric control dysfunction, low arousal, behavioral inhibition dysfunction, and attention-deficit disorder (Plizka et al., 2000). The result is due to biochemical abnormality and anatomy on prefrontal area cortex hypothesis of primary deficit in ADHD as proposed by Barkley (1998). The results of EEG discovery, brain morphometrics, neurochemical changes, and molecular genetic abnormality, showed how ADHD is related to deviation in early brain development (Zametkin et al.,1998).

The result of this research related to the dysfunction of the prefrontal area encouraged another research on diagnosis precision, that is, functional brain activity measurement or brain waves activities on cortex frontal area. This research covers: first, the investigation of brain waves on cortex frontal area in relation with neuropsychology investigation of ADHD patients (Barkley, Grodzinsky, & DuPaul, 1992), second, Q-EEG check-up, which is event-related potential in ADHD patients (Kuperman, Johnson, Arndt, Lindgren, & Wolraich, 1996; Satterfield et al., 1994), and the third, Q-EEG check-up using power spectral analysis (Power Spectral Analysis, PSA) to study further cortical activation pattern (Chabot et al., 1996; Mann, Lubar, Zimmerman, Miller, Munchen, 1992).

The result of Monastra et al.'s research (1999), involving 482 respondents, aged 6-30 years old, showed that there was a deceleration of brain wave activities on cortex prefrontal area and this condition confirmed the influence of maturational effect in ADHD patients. From this research, theta/beta power ratio was higher in case group compared to that in control group, with the sensitivity of 86% and the specificity of 98%. Therefore, this finding, then, was the pioneering work employing brain physiology scan result as an indicator of ADHD problems. Then, in later researches involving 314 children and adolescents with psychiatric problems (176 ADHD patients, 138 affective problems, anxiety disorders, dan defying actions), Monastra and Lubar discovered that ADHD patients had more power ratio in theta/beta compared to psychiatric problem patients ($p < .001$), with the sensitivity of 78% and the specificity of 95%. This condition showed that ADHD problems with the pathophysiology background of cortical hypoarousal. This finding is in accordance with the scanning results of Positron Emmision Tomography (PET) and Single Photon Emission Computerised Tomography (SPECT) in ADHD patients, they are, hypoperfusion and the decrease of metabolism activities on cortext prefrontal area and caudate nucleus (Zametkin et al., 1990; Zametkin & Rappoport, 1987).

Neurofeedback Therapy

The use of brain wave activity imaging has functioned as a feedback for patients when they are involved in conditioned behavior training done since 1970. This type of behavioral therapy was started by Professor M. Barry Sterman (UCLA School of Medicine, Department of Neurobiology and Behavioural Psychiatry, USA). At that time, a research on how far our brains could be changed or normalized through conditioned behavior training with operant conditioning principles. At the beginning, a training was done to increase alpha waves activities for relaxation (Sterman, 1996). Researchers from UCLA conducted a research on brain waves training on uncontrollable epilepsy patients (Hammond, 2006). At this time, Q-EEG checkup and neurofeedback therapy were used for assessment and therapy on several psychiatric and neurologic disorders, such as: ADHD, learning difficulties, epilepsy, brain coercion, stroke, alcoholism, substance misuse disorder, anxiety.

Neurofeedback therapy is a process/learning strategies to improve brain capabilities to produce brain waves activities. The changes of the brain waves are presented to patients, so that patients could train or learn to change their brain activities. The picture of brain waves activities is presented to the patients in order that the patients are trained in changing their brain activities. During training, one or two elecrodes are placed on scalp, and two electrodes on earlobes. Those electrodes measure brain waves activities on specific areas (vertex, Cz). Brain waves data are digitally recorded and processed and then are presented in graphic formats.

Neurofeedback therapy in the last decade has been selected as one of the therapy options and it is given in the form of additional therapy for ADHD patients (Heinrich et al., 2007). Basically, the basic of this therapy is neuro-behavioral therapy which develops patients' self-control towards brain wave activities, and then, their daily lives. ADHD children use these two types of protocols, they are, Slow Cortical Potentials (SCP) and theta/beta trainings.

SCP trainings are related to cortical existence regulation. SCP itself originates from sensorimotor cortex activities. Negative SCP indicates the increase of excitation and the preparation of action, as readiness to act on and to think about something. Meanwhile, positive SCP is related to the conditions of behavioral inhibition.

Theta/beta trainings are to reduce theta waves activities (4-8 Hz) and to increase beta waves activities (13-20 Hz). As a consequence, this condition lowers theta/beta power ratio in brain waves activities (EEG). By the time children start having alertness and relax, theta/beta ratio will be lower.

The EEG picture during recess period showed the increase of slow wave activities (delta and theta waves) and the decrease of alpha fast wave activities (8-13 Hz) and beta (13-30 Hz), mainly on frontal and central areas. This condition is the same as found in ADHD children, through the activities of central nervous system in low arousal condition (Gevensleben et al., 2009). Neurofeedback training is viewed as a way to improve specific cognitive functions or abilities to concentrate. Based on this understanding, ADHD children are able to use neurofeedback training to improve their self-regulation abilities and afterwards, to apply these abilities in their daily lives.

Is There Any Benefit From Neurofeedback Therapy on ADHD Children?

A number of research papers within the last twenty years confirmed positive results of neurofeedback therapy in ADHD children. A variety of research papers highlighted behavioral improvement in ADHD children, i.e. the decline in behavioral problems, and cognitive function improvements after the children had been treated with theta/beta ratio reduction and SCP trainings (Monastra et al., 2002; & Gevensleben et al., 2009).

Gevensleben et al. (2009) held a research on 102 children with ADHD, aged 8-12 years old. Respondents were randomly treated with neurofeedback therapy of 36 sessions or computerised attention skill training within two blocks for four weeks. Neurofeedback training covers two blocks, they are, theta/beta ratio and SCP trainings. From this research, ADHD children treated with neurofeedback trainings showed better therapy results compared to the ADHD children who were not treated. This confirmed that there is a benefit from neurofeedback therapy in ADHD children.

Fuchs et al. (2003) did neurofeedback therapy research in ADHD children and compared its results to what they did through giving metilfenidat in ADHD children. This research compared the results of 3-month neurofeedback therapy with metilfenidat treatment This research involved 34 respondents, aged 8-12 years old (22 respondents were neurofeedback group and the other 12 respondents were metilfenidat group. Neurofeedback therapy given in training improved the sensory motor rythm (SMR) cortex and beta waves activity 1 (15-18 Hz). The result of this research showed neurofeedback and metilfenidat groups had improvements in their parameters of medications, i.e. d2-TOVA (measuring concentration skills and IOWA-Conners Behavior Rating Scale). This proved that neurofeedback therapy generated benefits for children with ADHD (whose parents did not agree with the stimulants given).

Monastra et al. (2002) conducted a research on 100 children and adolescents with ADHD (American Psychiatric Association, 1994), aged 6-19 years old: 51 respondents got combined multimodal therapies with neurofeedback therapies and 49 respondents from control group got multimodal therapies without neurofeedback therapies. These therapies were administered for one year. Neurofeedback therapy administered in 34-50 sessions (each session lasted 30-40 minutes).

Multimodal therapy included metilfenidat (25 mg/day), parents' counselling, and academic supports. The research confirmed better results, they are, improvement in concentration and decrease in hyperactivity on multi-modal therapy group accompanied with neurofeedback therapy.

Discussion

The MTA Cooperative Group and Eunethyds (European Network for Hyperkinetic Disorder) recommended ADHD handling is multimodal therapy, including stimu-lant administering based on standards, optimal behavioral therapy, and psychoeducation for parents and teachers.

The effects of administering long-term stimulants have not yet been confirmed until today about its safety for patients' health. Aside from side effects, administering this medicine for long-term basis will lead to financial burden. In the USA, medical costs for ADHD children are assumed to be USD 1,678 annually. This, then, is possible to increase the living costs of a family with one ADHD child as much as USD 1,288 (Hammond, 2006; Marchetti et al., 2001). However, administering drugs will create real improvement. The result of the MTA Cooperative Group research showed that administering only behavioral therapy generated the same results as administering community care group (The MTA Cooperative Group, 1999).

Other types of therapy as neurofeedback therapy generate considerably therapeutic alternatives, especially when patients' parents reject the drugs, and when they are given to ADHD children from non responder group. A variety of research done showed that not all ADHD children were responsive towards the psychostimulant – 20% of ADHD children are non responders towards psychostimulants (Saputro, 2004).

Neurofeedback therapy in long term did not trigger harmful side effects; nevertheless, real and better behaviors did not directly appear. This neurofeedback therapy was more to learning processes, i.e. transformations in lifestyles and habits expected to stay for long term.

Conclusion

A wide variety of research has indicated that neurofeedback therapy is of great benefits and should be considered as one of the therapy options for ADHD children. Clinical observations and neurofeedback therapy research projects for children and adults with ADHD in Indonesian clinics must be done.

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