Effectiveness of neurofeedback training, behavior management including attention enhancement training and medication in children with attention-deficit/hyperactivity disorder – A comparative follow up study

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Highlights

Medications, neurofeedback and behavior management can benefit all domains of ADHD symptoms.

For inattention, hyperactivity & executive functions, medication management was the best.

For learning problems and peer relations neurofeedback produced the best results.

For aggression and defiance all three modes were equally efficacious

Abstract

Background

Attention Deficit/ Hyperactivity Disorder **(**ADHD) is one of the most common neurodevelopmental psychiatric disorders of childhood. Treatment of ADHD includes medications and Behavioral interventions. Neurofeedback, a type of biofeedback, has been found to be useful in ADHD. It helps patients to control their brain waves consciously. However, it is not yet conclusive if it is efficacious in comparison to behavioral management training and medication.

Aim

To compare the efficacy of neurofeedback training, behavior management including attention enhancement training and medication in children with ADHD.

Method

Ninety children between 6 and 12 years with ADHD were taken and randomly divided into 3 treatment groups equally- neurofeedback, behavior management and medication (methylphenidate). Conners 3-P Short Scale was applied for baseline assessment. The respective interventions were given and follow up was done at the end of 3 months by using

Conners 3-P Short scale to assess the improvement in the symptoms. There were 6 dropouts, the final sample size was 84.

Results

The medication group showed the greatest reduction of symptoms in inattention, hyperactivity, executive functioning domain (core symptoms of ADHD). No statistically significant difference was observed between Neurofeedback and Behaviour Management in these domains. Learning problems improved in all three groups, neurofeedback being the most effective followed by medication. Both Neurofeedback and Medication groups showed similar effect which was higher than the Behavioural Management group in Peer Relation.

Conclusion

Improvement in core ADHD symptoms have been observed with all 3 interventions with medication showing the greatest improvement Neurofeedback has been superior for learning problems. Thus, Neurofeedback can be an independent or combined intervention tool for children with ADHD in outpatient department of Psychiatry.

Introduction

Attention-deficit/hyperactivity disorder (ADHD) is one of the most common neurodevelopmental psychiatric disorders of childhood affecting about 5–7% of school-aged children (Shah et al., 2019). The disorder has a male predominance (Taylor, 2005). It runs a chronic course that can cause significant impairment into adolescence and adulthood (Spaniardi et al., 2017).

EEG studies have shown that ADHD patients have slower brain wave activity (theta) and less beta activity in comparison to normal individuals (Marzbani et al., 2016). Theta band activity (4–8 Hz) is negatively related to alertness and beta band activity (13–21 Hz) is positively related to attention (Loo, Makeig, 2012).

Treatment of ADHD includes various Pharmacological interventions - Stimulant medications (Methylphenidate, Dexamphetamine And Lisdexamphetamine) (Shah et al., 2019), Non-stimulant medications **(**Atomoxetine and Clonidine), third-line agents (Modafinil and Bupropion) (Shah et al., 2019) and non-pharmacological treatments like Behaviour Management Techniques (Pfiffner and Haack, 2014, Evans et al., 2014).

The Multimodal Treatment Study of Children With ADHD (The MTA Cooperative Group, 1999) have shown that while medications are effective in treating the core symptoms of ADHD, the combination treatments with social skills and parental training along with medications showed additional improvements in areas of psychosocial functioning, like

learning, social and family problems, behavioural and emotional problems (Jensen et al., 2001).

There has been an increasing interest in developing alternative non-pharmacological interventions in the treatment of ADHD, with long-lasting effects and minimal side effects. Neurofeedback appears to be such an alternative. Neurofeedback is a type of biofeedback. It is a method that helps patients to control their brain waves consciously by providing them feedback signals in real-time using an online feedback loop, in the form of audio, visual or both information (Marzbani et al., 2016, Baydala and Wikman, 2001, Enriquez-Geppert et al., 2019, Enriquez-Geppert et al., 2017).

Studies have revealed that ADHD children have larger amounts of frontocentral theta activity indicating decreased cortical activity and under arousal and an increase in theta band power has been found across the lifespan of children with ADHD. Also, there is decreased beta activity and thus an increased theta/beta ratio. Attempts to correct these abnormalities in EEG forms the rationale for neurofeedback (Loo, Makeig, 2012).

Children with ADHD have an under aroused power ratio, where slow waves (theta) are greater than fast waves (beta), therefore having difficulty in concentrating, processing information and poor executive skills. Joel Lubar was the first researcher who associated a high theta-to-beta ratio with ADHD children (Demos, 2019).

Therefore, theta-beta neurofeedback aims to reduce brain activity in the theta band and increase activity in the beta band (i.e. to decrease the theta/beta ratio) at the vertex electrode (Cz) (Marzbani et al., 2016, Heinrich et al., 2007). This treatment is effective in the reduction of hyperactivity, increasing focus, improving grades, improve sustained attention and child's behavior (Marzbani et al., 2016).

But it was inconclusive whether neurofeedback training can be at par efficacious with pharmacologic and behavior management. The objective of our study was to compare the effectiveness of neurofeedback training, behavior management including attention enhancement training and medication in children with ADHD.

Study design and setting

A repeated measure interventional study was conducted in children with ADHD attending Psychiatry OPD at a tertiary care institute over 12 months period. The protocol was submitted to and approved by the Ethics Committee of IPGME&R. Informed consent was taken from the parents of every child and assent taken from those children 7 years and above. 90 children aged 6–12 years diagnosed with ADHD as per DSM-5 (American Psychiatric Association, 2013) diagnostic criteria were taken and who had no

Baseline data

Baseline data showed several outliers in the sample groups. Hence median and interquartile range (IQR) is taken as a measure of central tendency instead of mean.Fig. 2.

Comparative analysis of background characteristics of different intervention groups

No significant difference in background characteristics was noticed among the three groups. The difference in the number of participants in each group was also not statistically significant (P value= 0.965).Table 1.

Comparative analysis of baseline T scores of conners scale among different intervention groups

No significant difference in T score in the different domains was noticed among the three groups. Table 2, Table 3.

Effect of different intervention on different domains of Conner's 3-P short scale

Discussion

This study compared three interventions in ADHD- Neurofeedback, Behaviour Management and Medication.

Conclusion

Medication, neurofeedback and behavior management along with attention enhancing task, when used independently can benefit all domains of ADHD symptoms. For core symptoms like inattention, hyperactivity/ impulsivity and executive functioning medication is significantly better than other two. Neurofeedback and behavioral management is inseparable. For other associated symptoms like learning problems and peer relations neurofeedback produced the best results.