Treating Autism Spectrum Disorder Using Pulsed EMF Therapy: A Case Series Report

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Abstract

Autism Spectrum Disorder (ASD) is a complex, multifaceted developmental disability and presents significant challenges for intervention. Applied Behaviour Analysis (ABA) is considered the standard of treatment for improving ASD symptoms but has limitations. Neuromodulation exists as a possible additional intervention for Autism Spectrum Disorder (ASD) that may be helpful for younger, lower functioning people. This study presents a series of 5 cases where young people with ASD were treated using transcranial pulsed electromagnetic field therapy (tPEMF). Pre- and post-treatment assessment using the Autism Treatment Evaluation Checklist (ATEC) revealed statistically significant improvements in total ATEC scores, and qualitative improvements in symptoms were also reported. Future research should focus on developing a clinical trial protocol to address the limitations of a case study methodology.

Keywords: Autism Spectrum Disorder, case study research, Autism treatment, tPEMF, tPEMF for Autism.

ARTICLE INFO	
RECEIVED	September 30, 2019
REVIEWED	November 25, 2019
ACCEPTED	November 25, 2019

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1. Introduction

There remains a need for effective interventions for young children with Autism Spectrum Disorder (ASD). Applied Behaviour Analysis (ABA) is a form of behaviour therapy (Lovaas, 1987), and is presently the behavioural treatment with the most evidence of efficacy (Medavarapu, Marella, Sangem & Kairam, 2019). ABA requires a very strong commitment on the part of caregivers and most research studies that have demonstrated improvements include a year or more of intensive training (Reichow, Hume, Barton & Boyd, 2018). Furthermore, there has been considerable variability in the outcomes of these studies with indications that this approach is more successful for higher functioning children with ASD (Reichow et al.).

Ideally, additional therapies would be faster, more effective, less intensive, and could be used alongside traditional behavioural methods. There are several biological and pharmacological interventions with empirical support for efficacy; however, these are beyond the scope of this paper (see Medavarapu et al., 2019 for a review). Neuromodulation exists as an alternative form of treatment, which may potentially have long-term benefits with little risk of harm. There are several modalities of neuromodulation, including EEG biofeedback, transcranial direct current stimulation (tDCS), and transcranial pulsed electromagnetic field (tPEMF) therapy. tPEMF neuromodulation provides stimulation using a low-power electromagnetic field applied trans cranially.

Studies of different neuromodulation modalities have demonstrated improvement in ASD symptoms (see Coben & Padlosky, 2007; Coben & Myers, 2009). These studies demonstrated significant improvements in symptoms of Autism. Many of these studies used quantitative EEG (qEEG) guided EEG biofeedback methods and almost all focused on older children, and children with high-functioning autism. There are several advantages to tPEMF therapy that make it well suited for lower functioning or younger individuals with autism, and this is a group for which fewer treatment options exist (Medavarapu et al., 2019). tPEMF therapy is often brief and applied passively, which can be beneficial for children with sensory sensitivity, anxiety, attentional difficulties and/or hyperactivity (Larsen, 2012). There are several commercial systems for conducting tPEMF therapy, and one that is widely available is the Low Energy Neurofeedback System (LENS; OchsLabs). LENS is a brief form of tPEMF therapy that provides transcranial tPEMF input at a frequency that is similar to the participants' own brain activity. In a LENS session, electrodes are applied to the client's scalp and ear lobes to measure their electroencephalogram (EEG). The LENS system then generates a tPEMF field that is briefly applied to the brain using the same electrodes, and at a similar oscillatory frequency to the brain's own dominant frequency (for more information about the mechanisms of LENS, see Ochs, 2006).

tPEMF therapy has been investigated for treating depression (van Belkum, Bosker, Kortekaas, Beersma & Schoevers, 2016). There is some evidence that tPEMF stimulates the release of Brain Derived Neurotrophic Factor (BDNF) in animals, which stimulated neuronal growth (Li, Yan, Liu, Li, Hu, Sun & Tian, 2014), and that it reduces inflammation by reducing cytokine levels (Rasouli, Lekhraj, White, Flamm, Pilla, Straunch & Casper, 2012). However, the mechanism of action is not definitively known.

There is a lack of empirical evidence for the efficacy of tPEMF for improving ASD symptoms. To our knowledge, one prior case study has been published describing the effects of tPEMF therapy in 2 young, lower functioning twin girls with ASD (Cripe, 2006). These cases demonstrated improvements in cognitive and social functioning and showed changes in EEG measures following treatment with LENS therapy. In this case series, we intend to expand upon prior published work by sharing our experience with using tPEMF therapy for five young, low functioning children diagnosed with ASD.

2. Methodology

2.1 Participant Identification

Participants were selected who met specified inclusion criteria. These criteria were having been diagnosed with Autism Spectrum Disorder at level 2 or 3 severity, aged less than 8 years old when treatment commenced, having completed pre- and post-treatment assessment using the ATEC, and received at least 10 sessions of tPEMF in the previous 12 months.

2.2 Demographics

There were five participants who met the inclusion criteria. They were all male and aged from 2 years 10 months to 7 years 11 months at the time of pre-treatment assessment. They completed between 10 and 20 sessions of tPEMF over a period of between 2 and 4 months.

2.3 Assessment

Participants' ASD symptoms were assessed using the ATEC (Mahapatra, Vyshedskiy, Martinez, Kannel, Braverman, Edelson & Vyshedskiy, 2018). This is a caregiver-reported measure of 4 subscales of ASD symptoms: speech/language/communication, sociability, sensory/cognitive awareness and health/physical/behaviour. Lower scores indicate less severe ASD symptoms and higher scores indicate more severe symptoms. The ATEC was developed as a tool to measure changes in ASD symptoms over time, and

normative ranges for expected developmental changes in ASD symptoms have been developed (Mahapatra, et al.). Participants were assessed prior to commencing therapy, and again following 10 sessions of treatment.

2.4 Overview of Cases

Descriptions of the 5 cases involved in this case series are presented below. They are comprised of caregiver descriptions of the child's behaviors and summarized results for each of the pre-treatment ATEC domains.

Case C1:
C1 commenced treatment at the age of 6 years and 11 months. He had been diagnosed with an Autism Spectrum Disorder level 3 at 2 and a half years of age. He also had a diagnosis of moderate to severe intellectual disability **a**nd severe speech delay. C1 had prior intervention with occupational therapy and had ongoing speech therapy. He also had previous intervention using ABA.
ATEC Speech/Language/Communication – C1 was able to speak approximately 10 words but was unable to speak in sentences. He could use 1,2 or 3 words at a time. Speech was not meaningful or relevant and no conversation was evident.
ATEC sociability – C1 had low social interest and generally avoided contact with others.
ATEC sensory/cognitive/awareness – C1 was described as someone with very limited understanding and was often unresponsive to both verbal and non-verbal communication.
ATEC health/physical/behaviour – Issues included constant bed wetting, anxiety and auditory sensitivity. C1 had rigid routines and could be fixated on certain topics.

Case C2:
C2 undertook his first treatment session when 2 years and 11 months of age. At 2 years and 5 months of age C2 was diagnosed with Autism Spectrum Disorder level 3. C2 had severe language delay.
ATEC Speech/Language/Communication – C2's language was generally non-existent except for the use of the word "no".
ATEC sociability – C2 was described as indifferent to others and was described as uncooperative with requests. He showed no eye contact and preferred to be alone.
ATEC sensory/cognitive/awareness – C2 was considered generally unresponsive to pictures and to his name and showed little external awareness.
ATEC health/physical/behaviour – C2 suffered from gastro-intestinal issues, sleep problems and could have outbursts of shouting and screaming.

Case C3:
C3 commenced treatment at 7 years and 11 months of age.
C3 had been diagnosed with Autism Spectrum Disorder level 2 at 4 years of age. He previously had undertaken ABA, occupational therapy and speech therapy. C3 had been prescribed risperidone which he took daily.
ATEC Speech/Language/Communication – C3 was able to use sentences of 4 or more words and was able to converse with others but was not able to communicate at age equivalent level.
ATEC sociability – C3 could be affectionate and cooperative but did not share with others and seemed indifferent to being liked.
ATEC sensory/cognitive/awareness – He played with toys appropriately and had some understanding of stories and could be imaginative on occasion.
ATEC health/physical/behaviour – Anxiety was a primary issue. He was sensitive to sound, had rigid routines, obsessive speech, was often agitated, could shout and scream and would occasionally hit others. He was very inflexible.

Case C4:
C4 commenced treatment at 3 years and 5 months of age.
His diagnosis of Autism Spectrum Disorder level 3 was confirmed 2 weeks prior to treatment. C3 had previously been diagnosed with language delay and had undertaken speech therapy and occupational therapy.
ATEC Speech/Language/Communication – He responded to his name inconsistently and would sometimes respond to "no" and "stop". He made single word utterances only.
ATEC sociability – C4 was generally indifferent to others and showed no eye contact, and displayed some temper tantrums.
ATEC sensory/cognitive/awareness – He responded to praise inconsistently. He did exhibit some curiosity and looked at pictures and sometimes played with toys.
ATEC health/physical/behaviour – C4 had a limited diet and was described as anxious and insensitive to pain.

Case C5:
C5 commenced treatment at 7 years and 6 months of age.
C5 was diagnosed with Autism Spectrum Disorder level 3 when 1 year 10 months of age. He also had a diagnosis of intellectual disability. C5's speech and language were significantly delayed although his early physical milestones were within normal limits. C5 had previously undertaken both speech and occupational therapy.
ATEC Speech/Language/Communication – C5 responded to his own name inconsistently and at times used single words but was unable to follow directions.
ATEC sociability – He typically ignored others, was uncooperative and preferred to be on his own. He was insensitive to other's feelings.
ATEC sensory/cognitive/awareness – He responded to praise and his own name on occasion. He looked at pictures sometimes and played with some toys appropriately. He was unable to follow stories.
ATEC health/physical/behaviour – C5 experienced frequent bed wetting and soiling, would hit and injure others and had obsessive speech and rigid routines.

2.5 Treatment

Participants were treated with tPEMF therapy using the LENSware 3 system (Ochs, 2006). For all clients, LENS was administered once per week. 3 participants completed 20 sessions of therapy, one completed 14 sessions and one completed 10 sessions. All participants received tPEMF feedback from a single channel A200 amplifier with the scalp electrode placed according the international 10-20 system. Reference and ground electrodes were placed at A1 and A2, respectively. Impedance was less than 10kOhm. Treatment duration ranged from 1-2 seconds per treatment, and 1-2 sites were chosen for treatment per session. There is limited published information on specific treatment protocol selection (see Larsen, Harrington & Hicks, 2006), and protocol selections were made based on clinical judgement for each case.

3. Results

3.1 Qualitative outcomes

The largest qualitative changes in parent ratings were found in the ATEC domains of speech/language/communication, sociability and sensory/cognitive/awareness. Changes in ratings relating to health and physical behaviours were less evident. While the areas of most significant improvement varied from child to child, improvement in the ratings relating to descriptions of improved external awareness was a common factor amongst all five children. This included ratings on items such as 'playing with toys more appropriately,' 'increased interest in looking at pictures,' and 'greater curiosity and more exploration of their immediate environment.'

3.2 Quantitative outcomes

ATEC domain pre- and post-treatment scores for each case are presented in Table 1:

Table 1: Comparison of pre- and post-treatment ATEC total scores

ID	Speech Pre	Speech Post	Sociability Pre	Sociability Post	Awareness Pre	Awareness Post	Health Pre	Health Post	Total Pre	Total Post
C1	27.00	22.00	37.00	17.00	33.00	18.00	14.00	6.00	111	63
C2	19.00	15.00	30.00	22.00	25.00	18.00	24.00	19.00	98	74
C3	5.00	5.00	13.00	9.00	19.00	13.00	29.00	20.00	66	47
C4	25.00	14.00	30.00	20.00	28.00	20.00	38.00	31.00	121	85
C5	21.00	4.00	15.00	6.00	18.00	6.00	11.00	11.00	65	27

Table 1 shows a reduction in total ATEC scores from pre- to post-treatment for all clients. A paired samples T-test was conducted to compare the post-treatment ATEC total score with the pre-treatment ATEC total score. There was a significant difference between the pre-treatment (M=99.0, SD= 25.7) and post-treatment (M=59.2, SD=22.83) total ATEC scores ($t(8)=2.59$, $p=0.032$).

4. Discussion

The outcomes of this case series indicate a statistically significant difference between pre- and post-treatment ATEC total scores in young boys with Autism treated using LENS tPEMF therapy. This suggests that treatment using tPEMF significantly reduced

symptoms of Autism as measured by parent ratings. Ratings relating to communication skills, sociability, cognitive awareness and general behaviour all improved significantly over a reasonably short period of treatment. This suggests the possibility that this could be a very appropriate early intervention for young autistic children. This is of particular significance, given the limited evidence-based interventions currently available for this population, and the agreed advantages of intervention that can be provided during the early developmental period.

Despite a very limited sample size, a statistical comparison of pre- and post-treatment ATEC total scores reached statistical significance. This highlights the need for further study involving a larger sample to investigate whether this effect is consistent and replicable. When compared to the ATEC's normative developmental predictions (Mahapatra, et al, 2018), the results showed improvements consistent with 1-2 years of development within 10-20 weeks of treatment. However, given the small sample and short time interval between assessments, a statistical comparison with these published norms would not be valid. This could be addressed by completing a 12-month follow-up ATEC assessment.

4.1 Limitations

This study has several limitations that must be taken into consideration. The first is that we are reporting on the outcomes of just 5 clients, all of whom were young males. This is not a highly representative sample and limits the generalisability of the results. Although statistically significant, quantitative outcomes should be interpreted with a great deal of caution. These is clearly a need for a study using a larger and more representative sample.

Assessment was also conducted using caregiver-rated questionnaires. These may be subject to observation bias, which may have inflated the significance of the findings. The clinicians involved in this study were also not blinded, participants were not randomised, and treatment was not standardised. These are all limitations that would need to be addressed in a larger study. Pre- and post-treatment Assessment of EEG would be useful to quantify changes in physiology as a result of treatment. However, EEG assessment is often challenging due to the sensory sensitivity, hyperactivity and/or anxiety that is often seen in young people with ASD.

The clients involved in the study were also undertaking other treatments such as speech pathology, occupational therapy and ABA alongside tPEMF therapy. This makes differentiation of treatment effects challenging, although it is also possible that tPEMF therapy may contribute to improvements achieved with other treatment modalities. Future studies could focus on the outcomes associated with combining therapeutic interventions, or by using a waitlist control design to account for improvements from other modalities.

4.2 Future directions

Despite these potential confounding factors, one value of a small case series such as this is to provide some preliminary data that might help inform the design of an experimental study. Future studies on this topic should develop a standardised treatment protocol. This would aid in replication of the results and would also help to determine the most useful treatment frequency, intensity and duration. In addition, the inclusion of a control group and randomised, blinded design would be helpful to limit observation and selection biases.

5. Conclusion

This case series has provided some preliminary outcome data on the use of tPEMF therapy for young children with ASD. We have also highlighted the need for thorough empirical investigation and provided suggestions for the design of a clinical trial to investigate the effects of tPEMF on symptoms of ASD. There are clearly many gaps remaining, but there are indications that this may be a promising direction for future research.

References

Coben, R., & Padlosky, I. (2007). Assessment-guided neurofeedback for autistic spectrum disorder. *Journal of Neurotherapy, 11(*1), 5-23.

Coben, R., & Myers, T. (2009). Neurofeedback for autistic spectrum disorder: A review of the literature. *Applied Psychophysiology and Biofeedback, 35(*1), 83-105.

Larsen, S., Harrington, K., & Hicks, S. (2006). The LENS (low energy neurofeedback system): A clinical outcomes study on one hundred patients at Stone Mountain Centre, New York. *Journal of Neurotherapy, 10(*2), 69-79.

Larsen, S. (2012). *The Neurofeedback Solution.* Healing Arts Press, Rochester VT.

Li, Y., Yan, X., Liu, J., Li, L., Hu, X., Sun, H., & Tian, J. (2014). Pulsed electromagnetic field enhances brain derived neurotrophic factor expression through L-type voltage-gated calcium channel- and erk-dependent signalling pathways in neonatal rat dorsal root ganglion neurons. *Neurochemistry International, 75*, 96-104.

Lovaas, O.I. (1987). Behavioral treatment and normal educational and intellectual functioning in young autistic children. *Journal of Consulting and Clinical Psychology, 55*(1), 3-9.

Mahapatra, S., Vyshedskiy, D., Martinez, S., Kannel, B., Braverman, J., Edelson, S.M., & Vyshedskiy, A. (2018). Autism Treatment Evaluation Checklist (ATEC) norms: A "growth chart" for ATEC score changes as a function of age. *Children, 5*(25), 1-12.

Medavarapu, S., Marella, L.L., Sangem, A., & Kairam, R. (2019). Where is the evidence? A narrative literature review of the treatment modalities for Autism Spectrum Disorders. *Cureus, 11(*1), 1-17.

Ochs, L. (2006). The low energy neurofeedback system (LENS): Theory, background and introduction. *Journal of Neurotherapy, 10(*2), 5-37.

Rasouli, J., Lekhraj, R., White, N.M., Flamm, E.S., Pilla, A.A., Strauch, B., & Casper, D. (2012). Attention of interleukin-1beta by pulsed electromagnetic fields after traumatic brain injury. *Neuroscience Letters, 519(*1), 4-8.

Reichow, B., Hume, K., Barton, E.E., Boyd, B.A. (2018). Early intensive behavioural intervention (EIBI) for young children with autism spectrum disorders (ASD). *Cochrane Database of Systematic Reviews, 9(*5), 1465-1858.

Van Belkum, S.M., Bosker, F.J., Kortekaas, R., Beersma, D.G.M., & Schoevers, R.A. (2016). Treatment of depression with low strength transcranial pulsed electromagnetic fields: A mechanistic point of view. *Progress in Neuro-Psychopharmacology & Biological Psychiatry, 71*, 137-143.