The Impact of the MNRI® Program on the Brain Stem Auditory Potential in Children with Cerebral Palsy

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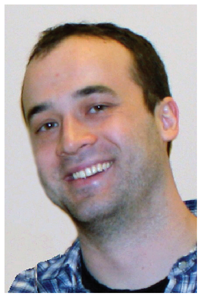
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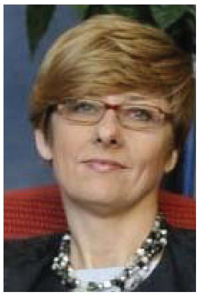
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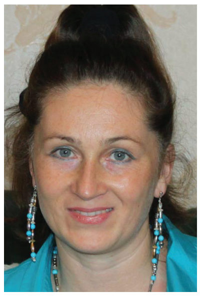
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Abstract

Brain stem auditory evoked potentials tests (BAEP) were administered to an experimental group of 17 children with cerebral palsy, ages 1.3 to 5.9 years, before and after a brief Masgutova Neurosensorimotor Reflex Integration (MNRI®) intervention. The authors sought to obtain objective validation of positive changes as a result of the use of MNRI® in children with neurological deficits. Results showed significant improvement in nerve transmission efficiency in those children immediately following the intervention. Thirty healthy children of equivalent ages served as a control group. The Interpeak Latency I – V subtest of the BAEP is of particular interest because of its potential use for intermediate assessment and diagnosis of neurodevelopmental motor delays and abnormalities.

Introduction

The purpose of this study was to use brain stem auditory evoked potentials (BAEP) tests to obtain an objective measurement of changes produced by Masgutova Neurosensorimotor Reflex Integration (MNRI®) in children with cerebral palsy. Evaluation of neurological deficits and disorders is usually based on observation of a patient's responses to stimulation of primary reflex motor patterns and performance in motor tasks. Because this type of assessment depends to such a large extent on the skills, possibly the psychological attitude as well, of the person performing the evaluation, results cannot be entirely objective. Brain stem evoked potentials testing relies on the registration of excitation waves appearing in the sensory pathways of the central nervous system due to activation of the appropriate receptor of an adequate stimulus. Testing results are independent of both the patient's and examiner's will or state of consciousness and are given as numerical values, which accounts for their replicability and objectivity.

MNRI® is a complex body of knowledge and therapeutic application oriented on primary motor reflex patterns. As L. Vygotsky and J. Piaget recognized, these motor patterns have an important role in motor, emotional and higher cognitive functions as well as in natural inherent brain stem survival mechanisms. Because professionals are only beginning to learn about this original and broadly applicable intervention, the Masgutova Educational Institute was eager for objective research-based validation of its efficacy.

Materials and Method

The study involved an experimental group of 17 children with CP, nine girls and eight boys, ages 1.3–5.9 years (mean= 3.8 years, SD = 1.3) and a control group of 30 healthy children of equivalent ages. Testing on the control group provided a baseline of normal competence for comparison with pre- and post-testing of the experimental group. The study consisted of three parts, carried out in one continuous session lasting about one hour:

1. BAEP pre-tests on experimental and control groups
2. Therapeutic intervention: one session of MNRI®
3. BAEP post-tests on the experimental group

Part 1 BAEP Pre-testing

The BAEP tests involved bilateral administration of a stimulus in the form of a click of 70 decibels at a frequency of 10 Hertz. The children in both groups received the stimulus through earphones and their responses were registered on a computer attached to electrodes positioned on their scalps. Each testing session lasted for about 15 minutes: 3 minutes to apply the electrodes, 2 minutes to register background noise, 5 to 7 minutes to present and measure responses to clicks, 2 minutes to register background after the clicks and 1 to 1½ minutes to remove the electrodes.

The most commonly used tests of brain stem evoked potentials involve auditory (BAEP) and visual (VEP) nerve transmission. A particularly useful test parameter in the evaluation of children with neurodevelopmental deficits is the Interpeak Latency I-V (IPL I-V). This subtest directly points at transmission efficiency in the brain stem segment of the auditory pathway and specifies in milliseconds (ms) the time that elapses between electrogenesis of the I segment (auditory nerve), and electrogenesis of the V segment (inferior colliculi of the mesencephalon).

Although developmental deficits resulting from injury are usually generalized in the brain, not limited to specific structures, the evoked potentials test directly assesses only one particularly sensitive area of the brain that is accessible to it. However, researchers have found that conditions and changes in this area correlate with conditions and changes in other inaccessible areas, including motor pathways and thus also overall motor development. Majnemer, et all, have used brain stem evoked potentials for clinical Assessment and prognosis in children with CP and Down syndrome and in infants at risk for perinatal CNS damage (Majnemer, Rosenblatt, Riley, 1990; Jiang, Wu, 1990, and Pilecki, 2002). Pilecki defined this use of EP tests to evaluate and project the level of transmission efficiency in other brain areas as "intermediate assessment" (Pilecki, et all, 2002).

Part 2 MNRI® Reflex Integration Exercises

The therapeutic intervention was a modification of a typical MNRI® session. It consisted of six consecutive reflex pattern activation exercises:

- Foot Tendon Guard Reflex (automatic dorsiflexion of the foot)

• Hands Supporting Reflex (parachute reflex)
• Leg Cross Flexion-Extension Reflex
• Spinal Galant Reflex
• Asymmetrical Tonic Neck Reflex
• diaphragm mobilization for the Breathing Reflex pattern.

These exercises involved hands-on stimulation of specific sensory-motor points on the limbs and trunk and passive manipulation of limbs and trunk in patterns associated with each reflex's motor response, all performed by the same trained MNRI® specialist. The children were lying on massage tables. For each of the above reflexes the exercise consisted of seven repetitions of a basic repatterning procedure, as described by S. Masgutova in her scientific-practical manual, *Infant Dynamic and Postural Reflexes: Neuro-sensory-motor Reflex Integration*.

Part 3 BAEP Post-testing

The previous BAEP test of IPL I-V was repeated. Due to heightened anxiety about the electrodes, two children in the experimental group were unable to participate in testing. Thus post-testing results were obtained on 15 out of the 17 children's experimental group. Post-testing took about 15 minutes, following the same procedure as the pre-testing.

Absolute IPL I-V Values

Raw data resulting from the brain stem response to an auditory stimulation (click) travels through electrodes placed on the scalp to a computer software program. The software then generates a score in milliseconds to express the amount of time that passes between the click and the brain stem response to it. This is the absolute IPL I-V Value.

The Interpeak Latency (IPL) parameter was selected for analysis because researchers frequently use it as an intermediate measure of CNS integrity. Although the absolute IPL I-V value is a widely accepted parameter, it has a significant disadvantage resulting from the fact that it is not constant in the first year of a child's life. It shrinks from about 5.10 millimeters at birth to approximately 4.05 millimeters by 12 months. Because of this unusual variability the standard deviation (SD) for scores must be extremely large, making statistical comparison of groups very difficult, even when their mean scores diverge.

In this study analysis of the absolute IPL I-V results was performed based on standards established in Dr. Pilecki's laboratory. He interprets values falling within ± 2 SD of the mean as normal. Lower than the mean by more than 2 SD then indicates shortened or accelerated transmission. Higher than the mean by more than 2 SD indicates elongated or slowed transmission (in this case lower is better, indicating more efficient, faster transmission). The unusual designation of ± 2 SD as normal was due to the extreme variability in scores for the younger age groups, as discussed above.

Results

Because testing was done separately for right and left sides, the number of results was double the number of children. Scores above 4.25 ms indicate slower transmission, a performance poorer than the norm. Scores below 3.85 ms indicate faster transmission, a performance better than the norm. Table 1 shows the number and percentage of students whose scores fell within the norm, slower (worse) than the norm and faster (better) than the norm.

IPL I-V values for right and left sides	Experimental group		Control Group
	Before MNRI® N=34	After MNRI® N=30	N=60
Within Norm (3.85 - 4.25ms)	4 (11.8%)	10 (33.3%)	60 (100%)
Extended (>4.25ms)	30 (88.2%)	18 (60.0%)	0
Shortened (<3.85ms)	0	2 (6.7%)	0

Table I. Absolute IPL I-V values within, above and below normal before and after MNRI®.

All the children in the control group scored within the range of the norm determined by Dr. Pilecki's laboratory (i.e. between the 3.85 ms and 4.25 ms.). Pre-testing scores for all children in the experimental group deviated from those of the control group and from the laboratory determined norm, all slower than the norm. As would be expected given their diagnoses, the extended time intervals indicated slower less efficient nerve transmission in the brain stem segment of the auditory pathway.

Following the brief MNRI® session the percentage of results indicating achievement within the norm increased from 11.8% to 33.3%. Results indicating slowed transmission (those in which the IPL I-V value was elongated) decreased from 88.2% to 60%. One child's post MNRI® IPL I-V value decreased to a speed even faster than the control group mean, better than the laboratory standard. Statistical analysis using the Wilcoxon test yielded p = 0.001 for the right-sided responses and p = 0.004 for left-sided responses. The Student's T-test for Pairs yielded p-values for the respective sides of 0.001 and 0.002. These results can be considered statistically significant with a high degree of confidence.

Experimental Group Pre-Test Absolute IPL I-V Results Compared to Control Group

In the experimental group, both the mean aIPL I-V values and the standard deviation differ considerably from those of the control group. The experimental group values were 1.24 ms higher for the right- and 1.09 ms higher for the left-sided responses. Variability within this group was also far greater, as seen in the larger standard deviation. The differences were statistically significant at the level of p <0.001.

Absolute IPL I-V value	Experimental group before MNRI		Control group	
	Right side	Left side	Right side	Left side
Mean	5.29 ms	5.14 ms	4.05 ms	4.05 ms
SD	1.39 ms	1.18 ms	0.10 ms	0.09 ms
Min.	4.24 ms	4.16 ms	3.85 ms	3.85 ms
Max.	9.20 ms	8.40 ms	4.25 ms	4.23 ms

Table II. Absolute IPL I-V values in experimental (before MNRI®) and control groups.

The mean absolute IPL I-V values in the experimental group, whose average age was 3.8 years, were worse (right 5.29 ms, left 5.14 ms) than in full-term newborns (5.10 ms). At the same time dispersion of the results was also enormous, from within the laboratory norm (minimum scores of 4.24 and 4.16) to a result (9.20) exceeding the average value of the control group (4.05) and the laboratory norm by nearly 50 standard deviations.

Pre- and Post-test Absolute IPL I-V Results in the Experimental Group

Mean values in the experimental group decreased after MNRI®. The right side improved (got faster) by .45 ms and the left side by .32 ms. Statistical analysis using the Wilcoxon test for the right and left sides was p = 0.001 and p = 0.004 respectively and the Student's t-test for pairs yielded p-values for the respective sides of 0.001 and 0.002, all significant with a high degree of confidence.

Absolute IPL I-V value	Before MNRI		After MNRI	
	Right side	Left side	Right side	Left side
Mean	5.29 ms	5.14 ms	4.84 ms	4.82 ms
SD	1.39 ms	1.18 ms	1.41 ms	1.14 ms
Min.	4.24 ms	4.16 ms	3.76 ms	3.84 ms
Max.	9.20 ms	8.40 ms	8.96 ms	8.24 ms

Table III. aIPL I-V values in experimental group before and after MNRI®.

Variation in transmission speeds remained very high, although it decreased: the minimum (fastest) response got faster by .48 ms on the right side and .32 ms on the left, and the maximum (slowest) got faster by .24 ms on the right and .16 ms on the left. Such changes are understood as improvement in transmission efficiency in the brain stem segment of the auditory pathway.

Relative IPL I-V Values

The extreme absolute IPL I-V score variability in the first year of life and the resulting large size of the standard deviation, as discussed above, makes comparison of groups very difficult, even when their mean scores diverge. To reduce this inconvenience Pilecki developed an additional parameter derived from his earlier research with test results from 411 children of adjusted ages from -8 to +78 weeks. This early research enabled him to give mean values week by week for age groups with differing SD values. In contrast to the absolute IPL I-V value, the relative IPL I-V results from a sophisticated mathematical equation that relates raw data from children with severe deficits to absolute scores of neurotypical children, standardized for ages week by week from ages -8 to +78 weeks. Scores are then expressed not in milliseconds, but in units that directly reflect their relationship to the standard deviation for the corresponding age group. Thus a relative IPL V–I of 5 or 12 indicates a result 5 or 12 SD below the mean for children of the same age. Use of the relative IPL V–I value is a new feature in this study.

The benefit of these new values is that they give a clearer measure of the degree of change from test to test and for very short age intervals. For professionals unfamiliar with evoked potentials, understanding the severity of deficit or degree of change shown in absolute BAEP test results can be challenging, because the standards are not widely known. By indicating how many standard deviations a result deviates from the mean of 1 standardized by age for the neurotypical population, the relative IPL I-V value enables average physicians to interpret BAEP test results more easily.

In addition to giving scores that directly reflect a relationship to the norm, the mathematical formula that generates relative IPL I-V scores also amplifies their numbers, so that differences are more clearly apparent.

Thus in both groups the maximum values reach highs near 50 units, deviating from the mean of 1 determined for the standard group by up to 50 SDs. Improvement after MNRI® was also very great: 4.5 units for the right side and 3.2 for the left. Though not shown in this report, variability among individual children's scores and in their changes from pre- to post-testing was likewise very high. The largest improvement in relative IPL I-V value after MNRI® for an individual child was 15.2 units (from 14.7 before MNRI® to -0.5 after). In this child the initial deficit of 14.7 standard deviations below the norm jumped to 0.5 of one standard deviation above the norm! Other individual results were less spectacular: some children improved only slightly and in two cases there was a slight deterioration.

Discussion

The data obtained from pre- and post-testing showed clear improvement in transmission efficiency in the brain stem segment of the auditory pathway immediately following a brief MNRI® session. The fact that all other testing conditions remained constant in both rounds and the MNRI® intervention was the only variable suggests very strongly that MNRI® caused the improvement.

Relative IPL I-V value	Before MNRI		After MNRI	
	Right side	Left side	Right side	Left side
Mean	12.4	10.9	7.9	7.7
SD	14.0	11.8	14.1	11.4
Min.	1.9	1.1	-2.9	-2.1
Max.	51.5	43.5	49.1	41.9

Table IV. Relative IPL I-V values in experimental group before and after MNRI®.

Variability in the outcome from child to child was not surprising, as the experimental group included children in whom CP differed in both etiology and severity. The fact that statistical analysis showed these positive results to be highly significant is all the more remarkable given the fact that post-testing followed a one-time-only and very brief therapeutic intervention.

The question of the sustainability of this improvement remains open. However, such an immediate low result, especially following only one very brief therapeutic intervention, can be seen as a positive sign. In the authors' experience any such clear indication of plasticity suggests that improvement is possible and that regularly performed exercises should enhance sustainability. Fortunately, the children participating in this study are under continuous observation and further studies are in process.

Another open question of great interest to those concerned with motor development, involves the relationship between improvement in the auditory pathway and improvement in mobility. Many authors have pointed out this possibility, claiming that brain stem auditory potentials are of great diagnostic and prognostic importance when it comes to motor development (Pilecki, 2003; Pilecki, Szawrowicz, Jagielski, Janocha, Borodulin-Nadzieja, 2002; Yilmaz, Degirmenci, Akdas, Kulekci, Ciprut, Yuksel, Yildiz, Karadeniz, Say, 2001; Scalais, 1998; Pike, Marlow, 2000; Majnemer, Rosenblatt, 1995). Dr. Pilecki also found a close relationship between mobility and the IPL I-V parameter (Pilecki, Szawrowicz, Jagielski, Janocha, Borodulin-Nadzieja, 2002). He described BAEP test results as an "intermediate diagnosis." Although the term is of his authorship, the rule he applied is widely accepted among researchers, who use the BAEP test both for measuring motor development and for its prognostic value (Yilmaz, Degirmenci, Akdas, Kulekci, Ciprut, Yuksel, Yildiz, Karadeniz, Say, 2001; Majnemer, Rosenblatt, 1995).

Further support for the use of this 'intermediate assessment' comes from other research by Pilecki, in which he found that in healthy children, the ability to walk independently is associated with the achievement of a certain transmission speed in the brain stem segment of the auditory pathway. He demonstrated that this relationship was more than a coincidental simultaneous convergence of two developmental processes. In the children he observed with slowed brain stem transmission, manifested by elongation of the IPL I-V, the development of independent walking was also delayed. Those children only learned to walk when the IPL I-V value decreased to about 4.25 ms (Pilecki, Szawrowicz, Jagielski, Janocha, Borodulin-Nadzieja, 2002).

The authors look forward to further research (e.g. based on wavelet analysis or single responses), using the equipment capabilities and the professional expertise of the Department of Pathophysiology of Medical University of Wroclaw, to expand their knowledge and understanding of these promising possibilities (Kipiński, Maciejowski, 2010).

Conclusions

1. BAEP pre- and post-testing showed significant improvement in transmission speed in the brain stem segment of the auditory pathway in an experimental group of 15 children with CP following a brief therapeutic session of MNRI®, as measured by changes in absolute and relative IPL I-V values.

2. Statistical analysis using the Wilcoxon test and the Student's t-test for pairs yielded p-values ranging from 0.004 to 0.001, indicating that results were significant at high level of confidence.

3. BAEP test results strongly suggest that MNRI® exercises can have a rapid and significant positive effect on brain stem functions in children with neurodevelopmental delays and abnormalities.

4. The possibility that BAEP results reflect changes in other areas of the brain, including motor pathways lying in the direct proximity to the brain stem segment of the auditory pathway, opens the prospect of potentially very wide use for that test.

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